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THE
ANATOMY OF THE LARGE AMERICAN FLUKE
(*FASCIOLA MAGNA*),
AND
A COMPARISON WITH OTHER SPECIES OF THE
GENUS *FASCIOLA*, S. ST.

BY
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CONTAINING ALSO A LIST OF THE
CHIEF EPIZOÖTICS OF FASCIOLIASIS (DISTOMATOSIS)
AND A
BIBLIOGRAPHY OF FASCIOLA HEPATICA.

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CONTENTS.

INTRODUCTION.

List of epizootics (By A. Hassall).

I.—*Fasciola magna*:

Synonymy.
Hosts.
Literature.
Geographical distribution.
Historical review.
Morphology.
Specific diagnosis.

II.—*Fasciola hepatica*:

Synonymy.
Hosts.
Specific diagnosis.
Intermediate hosts.
Literature (By Albert Hassall).

III.—*Fasciola gigantea*:

Synonymy.
Hosts
Geographical distribution.
Literature.
Historical review.
Specific diagnosis.

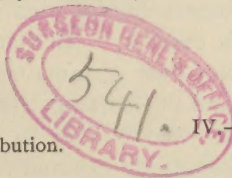
IV.—*Fasciola Jacksoni*:

Synonymy.
Host.
Geographical distribution.
Literature.
Historical review.
Specific diagnosis.

V.—*The generic name FASCIOLA.*

VI.—*Conclusions.*

VII.—*Compendium of Fasciolas,*
Arranged according to the hosts.



INTRODUCTION.

It has been known for many years that liver-flukes are found in a number of the domesticated animals, and that they at times cause a high rate of mortality on the farms, more especially among the sheep and cattle. The form which has heretofore attracted the most attention is the "common liver-fluke" (*Fasciola hepatica* L.), which has repeatedly caused serious damage to the sheep industry of various countries, as is shown by the following :

LIST OF THE CHIEF EPIZOÖTICS OF FASCIOLIASIS (DISTOMATOSIS).

COMPILED BY ALBERT HASSALL.

Unless otherwise stated the epizoötic was caused by *F. hepatica*. The data of the earlier outbreaks are necessarily very incomplete.

1500—1599.

- '26. Cosimus observed an epizoötic of distomatosis in Holland (after Wolfgang Franzius), cited from Braun.
- '42. Gentiles Arnulphus. Cited by Haller.
- '47. Gabucinus.
- '52. Cornelius Gemma refers to an epizoötic in Holland. Davaine states that this is the first epizoötic of distomatosis mentioned in history. Gemma speaks of the outbreak as "*lues infanda pecoris*" (unheard of pestilence of sheep).

1600—1699.

- '63-'65. In the Duchy of Coburg, Fromann observed an epizoötic which attacked the sheep of all ages, the calves and heifers up to two years of age, but not the oxen or cows. The hares and deer on the plains and forests died of this disease. Horses, goats and hogs were not exempt. In four folds, containing more than 3,000 sheep, not over 40 remained. (Davaine.)
- '64. Williéno Valentin. Island of Zealand. (Hurtrel D'Arboval). This could not be traced. See Willius '74.
- '74. Willius observed an epizoötic in Seeland in which nearly all the cattle were affected (Davaine).

Braun gives this epizoötic as due to "Blasenwürmer" (bladderworms—*Cysticercus*, *Cœnurus*, *Echinococcus*).

1700—1799.

- '35. Outbreak mentioned in Ellis' *Shepherds' Sure Guide* (1749), affecting the Vale of Aylesbury, England. Deer, sheep, lambs, hares and coneys (rabbits).

"The dead bodies of Rotten Sheep were so numerous that their carrion stench and smell proved extremely offensive to the neighboring parts and to passant travellers."

- '43-'44. Nearly all the sheep in the territory of Arles were destroyed. (Davaine.)
- '47. An epizootic in Vale of Aylesbury similar to that of '35.
- '61. All the flocks of Aveyron destroyed. (Davaine.)
- 61-'62. Great losses in sheep in northern part of France, especially in Bas Boulonnais. Very wet season. (Paulet, after Davaine.)
- '66. Outbreaks of distomatosis all over England. (Reported by Mills in Treatise on Cattle, 1776.)
- '92. Harrison (1804) mentions outbreak in England.

1800-1894.

- '09. Terrific epizootic in nearly all parts of France; in Beaujolais and Lyonnais, the entire herds of Merinos died. (Davaine.)
"The sheep constantly fed in the sheep-folds were generally preserved." (Grogner, cited from Neumann.)
- '09-'10. Fairbairn, under the nom de plume of "Lammermuir Farmer," lost 800 out of 2,000. (Treatise on the Cheviot and Black Faced Sheep.)
- '12. Disease prevailed in the Midi (France) and especially in the departments of the Rhone, Herault and Gard; 300,000 sheep perished in Arles territory, and 90,000 in the district of Nîmes and Montpellier. (Davaine.)
- 1810 and 1811 were very wet years. (D Arboval.)
- '16-'17. Bad years in England. (Simonds.)
- '16-'17. Distomatosis caused such destruction in France that the Government appointed a special commission to study the malady.
- '16-'17. Bad years for Germany. (Leuckart.)
- '20. Severe epizootic in environments of Beziers. (Davaine.)
- '24. Distomatosis very destructive in England. Mr. J. Cramp lost £3,000 (\$15,000) worth of sheep. (Simonds.)
- '29-'30. Caused destruction in the majority of the localities in the department of the Meuse and neighboring departments. In the vicinity of Montmédy, out of 24,000-25,000 cattle, 5,000 perished; more than half of the sheep perished. Some localities lost 2,000 head of cattle and 1,500-1,800 sheep. Didry, 1832. (Davaine.)
- In the vicinity of Verdun, of 20,000-21,000 cattle, 2,200

perished; of 50,000 sheep about 20,000 died. (Mangin, 1834, quoted from Neumann.)

'30-'31. Supposed to be the greatest outbreak England has experienced.

"Evidence of this immense destruction was given by various witnesses before the Parliamentary Committee, and it was satisfactorily ascertained that in 1833, two years afterwards, there were 5,000 sheep on every market day in Smithfield less than what used to be the average number, and 20,000 less than usual at Weyhill Fair." (Simonds.)

More than 2,000,000 sheep perished, representing a loss of £4,000,000 (\$20,000,000 !!!) (Edin. Vet. Rev., 1861, after Leuckart.)

'34. Rot in Egypt. Evidently not an epizootic. (The Veterinarian, 1834.)

'45. Spinola observed distomatosis in Poland (Polonge) and Russia, in conjunction with "la peste bovine." (D'Arboval.)

'51-'52. Epizootic in Wurtemberg. (D'Arboval.)

'53-'54. England. Many thousands of sheep were swept away. (Simonds)

France. Distomatosis reigned again in the greater part of France, especially in the departments of the centre; in Berry, Gatinais, and Logne, stockowners lost from one to three-fourths of their stock. (After Delafond, quoted from Davaine.)

Germany. In the single district of Liegnitz, hundreds of thousands of sheep perished (D'Arboval.)

'60-'61. "The outbreak, which took place in the autumn and winter of 1860, proved as serious as that of 1830-31. Speaking in general terms, it may be affirmed that all the western and southern counties of England, together with several of the eastern and midland, then suffered to a ruinous extent. As in former years, so in this, the attacks of the disease were due to an excess and long continuance of wet weather. Eighteen hundred and sixty will be long remembered by agriculturalists, not only as producing the rot among sheep, but likewise for its baneful effects on the root-crop, and on the hay and corn harvests.

"We are acquainted with several instances, in the immediate neighborhood of Harrow-on-the-Hill, where the losses of sheep amounted from 600 to 700 in a flock. . . . In the winter of 1860-61, some persons lost all their sheep, and one farmer in particular, who had purchased between 800 and 900

Welsh ewes, had not more than 40 or 50 which escaped. A similar fatality attended the progress of the disease in other districts. In many parishes in Devonshire, where we investigated the malady, and of which Bridgerule may be taken as an example, five-sixths of the sheep perished, or were sold for a few shillings each for slaughtering, to the detriment of the health of the poorer classes. The Rev. S. M. Kingdon, the then resident minister at Bridgerule, reported to the author, that on October 1st, 1860, 492 sheep were existing in the parish as the joint property of several small farmers; and that by the end of the month, 410 of them had either died or been sold at a price very little above the value of their skins. In the instance thus particularized, the losses occurred among the stock of small occupiers, the ill consequences were greatly added to by their *young cattle* being found to be affected with flukes to such an extent as seriously to injure their health later on in the year.

"In Sussex and in several parts of Surrey the fatality was equally great. In the neighborhood of Eastbourne, a flock of about 600 Southdown ewes of great value was completely destroyed. Numerous cases of a similar kind might be named, but enough has been said to show not only the extent of the disease, but that sheep of every description, and placed under different systems of management, in like manner succumbed to the rot. It is much to be regretted that means did not exist whereby the total loss could be ascertained. People are left in doubt as to the amount of food of which they were deprived in one year by this disease alone, and of the efforts which had to be made to replace the loss. The time, we predict, cannot be far distant when agriculturalists will be convinced not only of the propriety but of the positive necessity of making accurate returns of the annual *losses* they sustain among their stock, instead of simply deploring them among themselves. Elsewhere, we have drawn attention to this important subject, upon which very much might now be said, if it were not somewhat unsuited to an essay of this kind.

"In Ireland, however, in consequence of the excessive rainfall of 1862, the losses from rot during the winter of that year were enormous. Professor Ferguson, in reporting on the disease to the Irish Government in February, 1863, says: 'never in the memory of the present generation has there been in this country such mortality among the ovine tribe as there

is at present, and has been for the last few months, from what is generally designated rot.' To decide with any degree of accuracy the extent of the fluke malady existing at present, and that which existed during the past year, would be an impossibility.

"It, however, is my opinion that upwards of 60 per cent. of the sheep in the island are at present unsound, though not all to a fatal extent. . . . In 1861, there were 3,556,050 sheep in Ireland. In 1862, last year, at nearly the same period, when rot had not set in on its work of destruction, there was a deficiency of 100,163 from that number. That deficiency was incalculably increased during the remainder of this year. There will be a still far greater amount of deficiency this year (1863), an amount which I believe will be found greater than ever previously occurred in any year within the memory of the present generation, and certainly within the period of the Government collection of agricultural statistics." (Simonds '80.)

'72. Serious epizootic in the greater part of Germany. (D'Arboval.)

'72-'73. The great majority of sheep slaughtered at Strasburg during this winter had flukes in their liver. (Zündel.)

'72-'74. Bassi reports epizootic among the deer of the Royal Park near Turin, Italy. This epizootic was due to *F. magna*.

'76. Slavonia lost 40 per cent. of its cattle from this disease. (Neumann.)

'79. England lost about 3,000,000 sheep. (Fleming's Neumann.)

'80. England's loss estimated at 3,000,000. Youatt estimates the annual loss in England at 1,000,000 sheep. In Australia the disease is even more constant than in England. (Fleming's Neumann.)

'82. Wernicke reports an epizootic of this year in southern Buenos Ayres, in which at least 1,000,000 sheep were destroyed.

'86. During the first 8 months of this year more than 100,000 sheep were destroyed by flukes in the district of Tandil. (Wernicke.)

'89. Dinwiddie (vide infra) reports that for years the livers of cattle in Arkansas have been unfit for use. Mortality not given. (*F. magna*.)

'90. Francis investigated an outbreak in Texas where the loss ran up into hundreds of cattle. (Curtice.) *F. hepatica* or *F. magna*?

- '91. Fascioliasis prevalent among the dairy cows of certain districts in California. (Curtice.) *F. magna*.
- '91. "It is not generally known that the Trematoda bear an economic importance of the first magnitude to the live stock interest of Texas. . . . It is now three years since the investigations here recorded were begun. At first, the occurrence of enzoötics of 'Trematodism' were regarded as local, but on investigations it was found that these parasites cause serious damage almost every year." . . . (Francis.) Unfortunately, statistics are not given. *F. hepatica* and *F. magna*.
- '91. A very severe year for Australia. One farmer reports a loss of 10,000 sheep. (Live Stock Journal, Oct. 30, 1891. After Fleming.)
- '92. Lutz states that the liver-fluke has been recognized for some years in the Sandwich Islands, especially on Oahu. Only recently were its evil effects recognized. At time of writing, nearly the entire stock of cattle in some localities had been destroyed, while in other localities the disease was general but less severe.

In connection with these epizoötics it is interesting to note the ancient ideas which prevailed in regard to them. Zündel refers to the matter as follows :

"Formerly, when an epizoötic attacked the live stock, people were wont to attribute the malady to some supernatural influence, and often considered it a punishment from heaven. With this belief in some occult cause, the proprietor did nothing, or almost nothing, to combat the scourge ; people submitted to the will of God, and at the most they tried to appease the wrath of the Almighty by prayers and acts of devotion ; they tried to conjure the influence of the evil spirit—if they admitted that the epizoötic was the work of this one, by charms, by incantations, and even by exorcisms.

"A portion of this superstition, of this fatalism, has been preserved to our day, and often now, when an epizoötic breaks out in the stables of our cultivators, the latter submit humbly to their lot, not seeking the cause of the evil, not attempting to arrest its progress by means which their good sense should dictate to them."

Another liver-fluke, which has been known for some years, is a much smaller and less harmful one, the lancet-fluke *Distoma (Dicrocoelium) lanceolatum* Mehlis. We have not been able to find

any specimens of this species in this country, although Leidy* states that it is recorded as frequent in several of the Western States. The parasite is quite common in sheep and cattle in certain parts of Europe.

In the early part of this century it was shown that dogs and cats harbor liver-flukes, and according to the more recent researches of †Max Braun, three species must be recognized, i.e., *D. (Dicrocoelium) truncatum* (the truncated fluke), *D. (D.) felineum*, and *D. (D.) albidum*. All three of these flukes have been recorded in Europe, but thus far none of them have been found in this country. We have, however, found a new species of fluke in cats of New York, Maryland and the District of Columbia, which we will shortly describe. (See Notes on Parasites—21.) These parasites bring about a fluke disease in dogs and cats similar to, but less severe than the corresponding disease in sheep.

In 1847 Dr. Jackson showed that elephants also were infested with liver-flukes, and according to later accounts the worm which Jackson found in an elephant in Boston causes serious losses among the elephants in India. This worm has been named *F. Jacksoni*.

Some years later (1856) Cobbold showed that a somewhat similar parasite (*F. gigantea*) is found in giraffes, while in 1875 Bassi recorded another liver-fluke, which he named *D. magnum*, as the cause of a serious epizootic among the deer of the Royal Park, near Turin, Italy, during the years 1872–1874. Bassi's fluke was then supposed by most authors to be identical with the common fluke, *F. hepatica*.

Within recent years it has been noticed that the cattle in certain parts of this country are seriously infested with liver-flukes, and it has been determined that while *F. hepatica* is by no means uncommon in certain districts, the more common form is identical with the form discovered by Bassi, a worm to which the name *Fasciola magna* should be given. Dinwiddie has found that in some counties of Arkansas practically all the cattle harbor these parasites, and he has also found them in cattle from Indian Territory. Francis reports this form as very common in Texan cattle, a report which Dr. Melvin and myself can corroborate from our examinations of Texan cattle at the Chicago abattoirs.

As this parasite is so frequent in certain districts, and as it is so much larger than the common liver-fluke, *F. hepatica* that it

*Proc. Phila. Acad. Sc. 1856.

†C. f. B. u. P. XIV. pp. 381–392, 422–428. 1893.

must be looked upon as even a more dangerous parasite than that form, it is important for us to learn all we can of its history, structure and life-cycle, in order to be prepared to combat the disease it causes; at the same time, while studying one fluke, or one fluke-disease, it will be well to draw closely allied forms into comparison. As *Fasciola magna* has been described but very superficially heretofore, it became necessary to study the parasite more carefully in order to determine its exact relations to *F. hepatica*, and to obtain definite specific characters which would more easily distinguish it from that species, and it was also necessary to search the American literature for accounts of disease which could be referred to this parasite. This study of the literature and the anatomy—a necessary prelude to writing an intelligible specific diagnosis—resulted in the writing of this paper. The facts brought out in the paper, *i. e.*, that the anatomy of *Fasciola magna* is so very similar to the anatomy of *F. hepatica*, points to the probability that the life-history of the two forms will prove to be very nearly the same.

Before passing to the anatomy of *F. magna*, it may be well to consider for a moment how many different forms of liver-flukes are found in man and the larger domesticated animals. The following table gives a concise idea of our present knowledge of distribution of these forms in man, cattle, sheep, goats, horses, asses, hogs, dogs, rabbits, cats, elephants and camels.

Parasites.	<i>F. hepatica</i>	<i>F. magna</i>	<i>F. Jacksoni</i>	<i>F. gigantea</i>	<i>D. lanceolatum</i>	<i>D. sinense</i>	<i>D. conjunctum</i>	<i>D. truncatum</i>	<i>D. felineum</i>	<i>D. albidum</i>	<i>D. sp. nov.</i> <i>S. & H. MS.</i>	<i>Amphistoma</i> <i>explanatum</i>
Host..	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Man.....	x	.....	.....	.....	x	x	x	.....	.....	.....	.....	.....
Cattle.....	x	x	.....	.....	x	.....	.....	.....	.....	.....	.....	.....
Zebu.....	x	.....	.....	.....	x	.....	.....	.....	.....	.....	.....	x
Sheep.....	x	.....	.....	.....	x	.....	.....	.....	.....	.....	.....	.....
Goats.....	x	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Horses.....	x	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Mules.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Asses.....	x	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Hogs.....	x	.....	.....	.....	x	.....	.....	.....	.....	.....	.....	.....
Rabbits.....	x	.....	.....	.....	x	.....	.....	.....	.....	.....	.....	.....
Dogs.....	.....	.....	.....	.....	†	.....	x	x	x	.....	.....	.....
Cats.....	x	.....	.....	.....	†	x	.....	x	x	x	x	.....
Elephants.....	.....	.....	x	.....	.....	.....	.....	.....	.....	.....	.....	.....
Giraffes.....	.....	.....	.....	x	.....	.....	.....	.....	.....	.....	.....	.....
Camels.....	x	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....

x Present.

† The form described as *D. lanceolatum* in dogs and cats is *D. felineum*.

Of these parasites, the first four flukes form a very natural group of closely allied species, showing certain characters in common which justify us in separating them zoologically from the other flukes (cf. infra). These flukes are also the largest of the flukes, and at the same time the most dangerous. They are the only ones which will be considered in this paper.

The next seven flukes are much smaller, and do not produce such serious effects upon their hosts. They too present certain characters in common, some of which are entirely different from those of the genus *Fasciola*. They are placed in the sub-genus *Dicrocoelium* of the genus *Distoma*.

As members of the genus *Distoma*, they present the following characters* in common:

1. The animals are hermaphrodites;
2. The intestinal cæca are simple;
3. The ovary is round or lobate;
4. The testicles are round, lobate, or slightly branched;
5. The vitellogene gland is marginal, but not so profusely developed as that of *Fasciola*.

As members of the sub-genus *Dicrocoelium*, they present the following characters:

1. The intestinal cæca are long and simple;
2. The oral sucker is without spines or lobes;
3. An œsophagus is present;
4. The acetabulum is sessile;
5. The genital pore is immediately anterior to the acetabulum.

The sub-genus *Dicrocoelium* is subdivided into two sections, according to the relative position of the testicles to the uterus. Of the Distomes here under discussion, *D. lanceolatum* belongs to the first section of the sub-genus, and the remaining flukes to the second section:

First Section. The genital glands lie anterior to the uterus; a cirrus is present: *D. lanceolatum*.

Second Section. The genital glands lie posterior to the uterus; the testicles are never exactly side by side, but one is regularly more or less posterior to the other. The oral sucker is

*In this and the following tables the characters have been taken which are common to the flukes under discussion, but it must not be assumed that all of the characters mentioned will necessarily be found in all the other members of the respective groups. In other words, the characters given are not proposed as revised diagnoses of the different groups.

followed by a pharynx; there is no cirrus present; the vitellogene glands never extend posterior to the testicles.

In this section the flukes here under consideration naturally fall into two sub-sections:

a. Testicles round, oval or somewhat lobate; end portion of the excretory canal has a sigmoid course between the testicles: *D. conjunctum*, *D. felineum*, *D. albidum*, *D. sp. n.*, and probably *D. truncatum*.

b. Testicles branched; end portion of the excretory canal runs nearly straight and lies dorsally of the testicles: *D. sinense*.

The last fluke (*A. explanatum*) mentioned in the above list is found in India. The acetabulum is posterior.

In the present paper we will first study the large American fluke (*F. magna*), comparing it with the "common fluke," *F. hepatica*; from this we will pass to account of *F. Jacksoni* and *F. gigantea*, and a review of the question as to the generic name *Fasciola*. The "common fluke" (*F. hepatica*) has been so thoroughly studied by other authors that it is not necessary to go into an account of the anatomy any further than can be done in comparing it with the other forms.

The material at my disposal consists of a large number of specimens collected as follows:

1. Eight specimens of *F. magna* from *Cervus dama*, forwarded by Prof. Sonsino of Pisa, Italy.
2. Several specimens collected by Dr. Curtice at Colorado Springs (Hassall's type-specimens of *Fasciola carnosu seu americana*).
3. Several specimens collected by Dr. Francis in Texas, and sent to the late Prof. Leidy. These were determined by Leidy as *D. crassum* (Co-types of Francis' *Distomum texanicum*).
4. A number of specimens sent to this Bureau by Dr. Dinwiddie from Arkansas.
5. A number of specimens sent from Chicago by Dr. Melvin.
6. Eight specimens found by Dr. Hassall in a Texan steer slaughtered at Washington, D. C., March, 1893.
7. A number of specimens collected by myself in Chicago in August, 1893.

In the Chicago abattoirs about one-fourth of the Texan cattle I examined during August, 1893, had flukes (*F. magna*, *F. hepatica*, or both) in their livers. The parasites were found both in the bile-ducts and in the parenchyma. In most of the cases they were

contained in cysts (cf. Fig. 1, Pl. 1), two or three to ten or twelve in each cyst. These cysts varied in size from a walnut to an apple, and did not seem to be confined to any particular portion of the liver, but were found near the periphery, or near the center, on the convex surface, or on the concave surface, etc. No statistics were taken, however, to determine their relative occurrence in the different lobes. The cysts naturally produced an irregularity of the surface of the liver, so that they were easily detected. They were generally very hard, there being in many cases a calcareous shell surrounding the cavity. The cavity of the cyst contained, besides the flukes, a dirty greenish to brown or black substance of mushy or gritty consistence, in which were found numerous fluke eggs, blood corpuscles and a mass of gritty material. The livers containing these parasites were darker in color than the normal liver.


I. *Fasciola magna* (Bassi 1875).

PLATES I AND II AND FIGURES A-G.

SYNONYMY: 1875, *Distomum magnum* Bassi;
 1882, *Distoma grande* Perroncito, Italian (nec Rud.,
 1819, Latin);
 1887, *D. hepaticum* ex. p. Curtice;
 1889, *Fasciola hepatica* ex. p. Dinwiddie;
 1891, *F. carnosus* Hassall;
 1891, *F. americana* Hassall;
 1891, *D. texanicum* Francis;
 1891, *D. crassum* ex. p. Leidy;
 1892, *Cladocœlium giganteum* ex. p. Stossich;
 1894, *F. magna* (Bassi, 1875) Stiles.

COMMON NAMES: English—The Large American Fluke;
 German—Der grosse amerikanische Leberegel;
 Italian—Distoma grande, D. magno.

HOSTS: Cattle (*Bos taurus*), reported by Curtice, Francis, Dinwiddie, Hassall and Stiles;

 Blue Bull (*Bos indicus* ~~tragocamelus~~), Bassi;
 Sambur (*Cervus (Rusa) unicolor*), Bassi;
 Elk or Wapiti (*Cervus canadensis*), Bassi;
 Fallow Deer (*Cervus (Dama) dama*), Bassi, Sonsino;
 Stag (*Cervus elaphus*), Bassi;
 Virginia Deer or Red Deer (*Cariacus virginianus*), Leidy.

GEOGRAPHICAL DISTRIBUTION—North America: Texas (Francis);
 Arkansas (Dinwiddie, Hassall and Stiles); Indian

Territory (Dinwiddie); California (Curtice); Iowa (H. Osborn); Illinois, Union Stock Yards of Chicago, in Texan cattle (Stiles, Judd, Norgaard, et al.); Adirondacks, N. Y. (after Leidy). *Europe*: Italy (Bassi and Sonsino).

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- '92.—Ueber den grossen amerikanischen Leberegel; Centralblatt für Bakteriologie und Parasitenkunde, XI, pp. 797-799.

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PERRONCITO, E.—

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RAILLIET—

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SONSINO, Prospero—

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- '92A.—Notes on Parasites—7: A word in regard to Dr. Francis' *Distomum Texanicum*; American Veterinary Review, pp. 732-733. Abstract: JOURNAL COMPARATIVE MED. AND VET. ARCH., 1892, p. 148.

- '92B.—Notes on Parasites—11: *Distoma magnum* Bassi, 1875; JOURNAL COMPARATIVE MED. AND VET. ARCH., pp. 464-466.

- '94.—The Anatomy of the Large American Fluke (*Fasciola magna*), and a Comparison with other Species of the Genus *Fasciola*, s. st. Containing also a list of Chief Epizoötics of Fascioliasis (Distomatosis) and a Bibliography of *F. hepatica* by Albert Hassall (the present

paper); JOURNAL OF COMPARATIVE MED. AND VET. ARCH.

STOSSICH, M.—

'92.—I Distomi dei Mammiferi; Programma della civica Scuola Reale superiore. Trieste.

HISTORICAL REVIEW.

BASSI ('75) had occasion to observe an epizootic among the deer of the Royal Park near Turin, Italy, in which the symptoms shown by the animals were essentially the same as those shown by sheep infested with *Fasciola hepatica*. In the post-mortem examinations it was found that the deer were heavily infested with flukes, which differed somewhat from *F. hepatica*, and which Bassi then described as a new species, *Distomum magnum*. He was inclined to believe that the parasites were introduced in the Park by the Wapiti (*Cervus canadensis*). The effects of the entozoa became marked in 1872, and increased notably in 1873 and 1874, the disease being at its highest during the winter and spring. Bassi describes the pathological changes produced by the worm, but his description of the parasite itself is so unsatisfactory that LEUCKART ('79) and others did not hesitate to pronounce the fluke identical with *F. hepatica*.

PERRONCITO ('82) accepts Bassi's species, evidently taking his diagnosis from Bassi's article. His diagnosis is headed "Distoma grande. *Distoma magno* (*Distoma magnum*, Bassi)."

As Perroncito has headed the other species of flukes with the Italian names (cf. l.c. p. 273 *Distoma epatico*, p. 276 *D. lanceolato*, etc.) giving the Latin scientific name in brackets, I suppose that he intended to use the term *grande* as an Italian word, and not to propose it as a new Latin name for this species, especially as the specific term *D. grande* was already preoccupied by Rudolphi (1819) for a fluke in a South American Spoonbill, *Ajaja ajaja* (L.) (*Platalea ajaja*). As *grande* is, however, both a Latin and an Italian word, and as this point might possibly lead to slight confusion in indexing species, I have included the term *D. grande* Perroncito, 1882, among the synonyms.

CURTICE ('87) records three cases of pulmonary distomatosis in Kansas cattle. He considered the parasites identical with *F. hepatica*, but has since stated (personal conversation) that they were in reality *F. magna*. He also cites an article in the New York "Tribune" of 1870-71, by J. H. Batty, recording liver-flukes in Virginia deer. Curtice adds: "The species is undetermined, but closely resembles *D. hepaticum*, which it probably

was." Curtice also cites A. J. Murray (Veterinary Review, 1882), as recording three cases of pulmonary distomatosis in Texan cattle.

DINWIDDIE ('89) had occasion to examine a large number of cattle affected with these flukes. He stated that for years the livers of cattle from certain districts had been unfit for use. As the district covered by this disease fell within the permanently infected area of Texas cattle fever, a number of persons had supposed that the changes brought about by the liver-fluke were due to Texas fever. Post mortem account of a steer, four years old, is given as follows:—

"Apparently in good health and fair butchering condition. The 'fat caul' seen on first opening the abdomen as a large sheet, was dotted with black spots and streaks. Lymphatic glands on the concave surface of the liver were much swollen and black in color. The liver itself was enlarged and darkened on the surface, with a number of prominent elevations, some appearing like blisters, and some more or less solid, and varying greatly in size. A longitudinal section showed the presence of many cavities, some containing a dark fluid in which were floating granules and shreds of tissue. One very large cavity, about two inches in diameter, with irregular yellowish colored walls, besides the dark colored fluid above mentioned, contained also two flat, leaf-like bodies about one inch in length and slightly less in breadth. They were fished out and recognized as 'Flukes.' . . . More of these were obtained from other cavities. Several other cavities contained solid, greenish, yellow gritty matter, and no parasites. A section made through the liver in any direction, cut through one or more of these cysts. They were situated near the surface of the organ or in its substance indiscriminately. Those that contained the 'Fluke' were usually of medium or smaller size, and the parasite was found folded or curled upon itself longitudinally and surrounded by fluid. . . . The shreds of tissue found in those cysts, which did not contain the living parasites, were shown by microscopic examination to be the débris of dead and partly decomposed Flukes.

"Such were the gross appearance of the livers of at least three-fourths of the cattle slaughtered during the spring and summer at this place, and of about ninety per cent. of all coming from certain ranges in St. Francis and Lee counties."

In August and September this condition was common, no living flukes being found.

Dinwiddie then gives a short description of the parasite, the life-history of *F. hepatica*, and practical measures to be adopted to prevent the disease. From the figure given, as well as from Dinwiddie's latter statements, it is evident that the parasite he

found was *F. magna*, although he at that time called it *F. hepatica*.

As the summer advanced, Dinwiddie noticed that the flukes were less common in the livers, but that "cicatrices or scars, the evidence of former inflammatory actions," were found.

OSBORNE ('90) examined some "leeches" which had been found in a deer, and determined them as "liver-flukes." It seems probable that they belonged to this species.

SONSINO ('90) records this species from *Cervus dama* in Italy. He expresses the opinion that the form may be identical with *F. gigantea* Cobbold. [Original paper not at hand, I quote from Braun's review.] Sonsino records a specimen 10 cm. long.

An article appeared in the Pacific Rural Press, in which a farmer stated that a disease was prevalent among the dairy cows of a certain district. He opened one of them and found "thousands of parasites, resembling diminutive flat-fish." In reply to this letter Dr. CURTICE ('91) stated that the parasites in question were liver-flukes, and more recently, in private conversation, he has told me that the species found in this case was identical with the species now under discussion. In the article referred to, Curtice states that Francis had the winter previous investigated an outbreak in Texas, where the loss ran up into hundreds of cattle.

HASSALL ('91A) found several specimens of flukes (collected by Curtice) in the collection of this Bureau under the label *D. hepaticum*. He recognized that they were distinct from *F. hepatica* and gave a short description of them as *Fasciola carnosus* sp. n. Later ('91B) Hassall changed the name to *Fasciola americana*, since the specific name "*carnosus*" had already been given to another fluke (*Distoma carnosum* Rud. in *Dentex vulgaris*).

About one month later, FRANCIS ('91) re-described the same parasite; not being acquainted with Bassi's paper, and overlooking Hassall's two publications, he re-named the species *Distomum Texanicum*. Attention was called to this by Stiles in his review of Francis' paper, and by LEUCKART ('92).

The largest flukes Francis found measured 73 mm. long. Usually 10-15 were found in a single liver, but upon one occasion 27 were found. They are described as wandering aimlessly around in any direction, "in channels which they had produced. . . . The majority are near the convex or outer surface of the liver. The channels they produce admit the little finger, and seem to heal or fill up soon after, leaving a red scar. Sometimes they perforate the surface of the liver, then suddenly turn back into the liver again. I think that they sometimes leave the liver and bore

into adjoining tissues or organs, but I have not found them in other places than the liver."

LEIDY ('91) examined specimens sent to him by Francis, and also specimens from *Cariacus virginianus* (Adirondack Mountains, N. Y.), and from a calf from Hot Springs, Ark. He determined the forms as identical with *Distoma crassum*, which he had found in a Chinese boy. Not knowing how prevalent the large fluke really was in America, he thought it possible that the worms were introduced into this country by immigrants from China.

STILES ('92A) states that the parasite described by Francis as *Distomum texanicum* is identical with Hassall's *Fasciola americana* and probably identical with Bassi's *D. magnum*.

DINWIDDIE ('92) states that in four or five counties of Arkansas practically all the cattle harbor these liver-flukes, while in many other counties, as well as in cattle from Indian Territory, the disease is occasionally met with. The livers of these cattle are unfit for food. He has never found this particular form in sheep. Dinwiddie says that when he first found these parasites he doubted whether they were really identical with *F. hepatica*, although he at that time published them under that name.

FRANCIS ('92) in his second paper, adds nothing of any scientific nature, but discusses the question of priority. A reply to this paper may be found in a postscript to my Notes on Parasites—II.

LEUCKART ('92) examined a specimen of *Fasciola americana*, compared it with one of Bassi's original specimens of *D. magnum*, and pronounced the two specifically identical. He considers that *D. magnum* was introduced into Italy by **Cariacus virginianus*.

STILES ('92B), not knowing that Leuckart's paper was in press, examined eight specimens of Bassi's *D. magnum*, sent to him by Sonsino, and states that there is no doubt in regard to the identity of this form with the American species, *Fasciola americana* (*D. texanicum*).

STOSSICH ('92, p. 9) unites this species with *F. gigantea* under the term *Cladocelium giganteum*.

Braun's statements ('93) are based upon Leuckart's article ('92).

Specific name.—I have already shown in another paper ('91) that the specific name *magna* should be retained for this species.

* Leuckart undoubtedly intended to refer to *Cervus canadensis*, the Wapiti.

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No. 4.

THE ANATOMY OF THE LARGE AMERICAN FLUKE (*FASCIOLA MAGNA*), AND A COMPARISON WITH OTHER SPECIES OF THE GENUS *FASCIOLA*, S.ST.

BY CHAS. WARDELL STILES, PH.D.,
Zoologist, Bureau of Animal Industry.

CONTAINING ALSO A LIST OF THE CHIEF EPIZOÖTICS OF
FASCIOLIASIS (DISTOMATOSIS) AND A BIBLIOGRAPHY
OF *FASCIOLA HEPATICA*.

BY ALBERT HASSALL, M.R.C.V.S.

(Continued from page 178.)

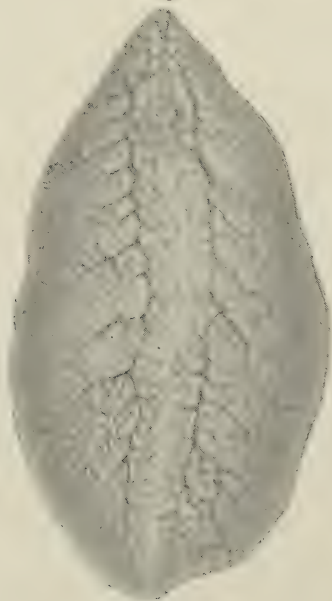
MORPHOLOGY.

External appearance —When examined immediately after being taken from the liver or lungs, *F. magna* is usually of a fleshy tinge, hence Hassall's specific name *carnosa*, occasionally more of a slate color, its dorsal surface being lighter than its ventral surface. In form it resembles a flat fish or a leaf, to a certain extent. In the general contour (Plate I, Figs. 2 and 3, and Plate II) of the body there is considerable difference between *F. magna* and *F. hepatica*. Although in both forms the worm presents a conical anterior portion limited posteriorly by the acetabulum (ventral sucker), and a posterior portion which is flatter and broader, the division between the two regions is much less distinct in *F. magna* than in *F. hepatica*. In fact in most specimens of the former species, the conical form

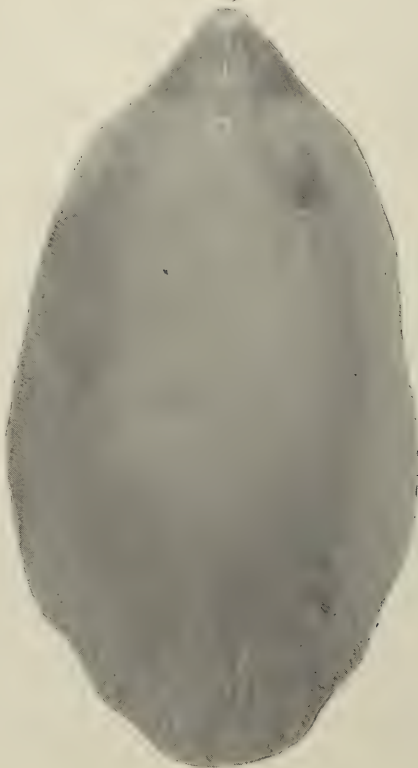
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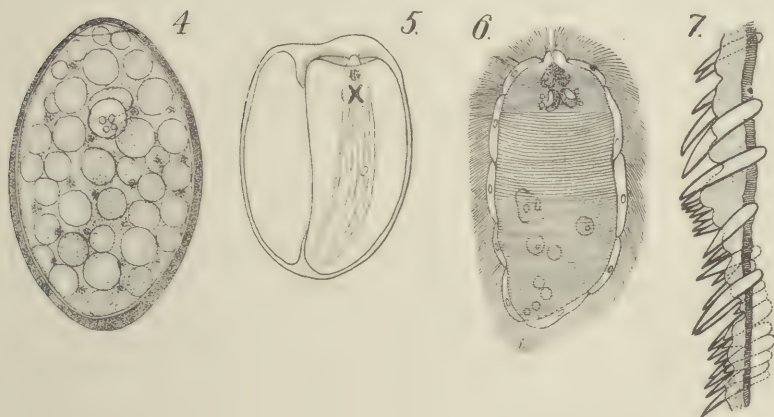


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3





EXPLANATION OF FIGURES.

PLATE I.—*Fasciola magna*.

Fig. 1. *F. magna* cyst from the liver of a Texan steer.

Fig. 2. Macerated specimen showing digestive system and acetabulum. x 2.

Fig. 3. Macerated specimen showing mouth, pharynx and oesophagus, genital pore with extended cirrus, uterus and shell-gland, all in the median line; two ventral longitudinal nerves run from the pharynx, diverging posteriorly to a point somewhat beyond the middle of the worm; at the right of the uterus is the ovary; the transverse vitellogenic duct runs from the shell-gland to the profusely developed vitellogenic glands, the latter taking in the margins of the worm from the acetabulum to the posterior extremity. The testicles are in the middle field, the right testicle somewhat posterior to the left. x 2.

Fig. 4. Egg showing the germ-cell surrounded by a large number of vitelline cells, and an egg-shell provided with a cap on the anterior end.

Fig. 5. Ciliated miracidium within the egg-shell.

Fig. 6. Free miracidium, showing ciliated epithelium, "boring papilla," rudimentary oesophagus and intestine, the two cup-shaped eye spots situated above the ganglionic mass. Germ-cells are seen in the posterior half of the body.

Fig. 7. A section of cuticle with spines.

of the anterior portion disappears entirely, the two shoulders so common in *F. hepatica* at the height of the acetabulum, being replaced by a convex margin, so that there is no marginal boundary between the anterior conical and the posterior flat portion. Specimens are occasionally found which agree perfectly with Cobbold's figure of *F. Jacksoni*. The portion in front of the acetabulum is lighter than the portion posterior to the same. The darker tint of the posterior portion is due to the intestines and genital organs.

The contour (Plate II) of the worm varies greatly according to the state of contraction. In general, however, it may be said that the broadest portion of the worm is the middle third of the body. The anterior third decreases in breadth quite rapidly and the anterior extremity is more or less bluntly pointed. The posterior third decreases in breadth much more gradually and the posterior extremity is quite bluntly rounded. In the case of *F. hepatica* on the other hand, the posterior fourth of the body becomes quite narrow in comparison with the middle of the body and the posterior extremity is bluntly pointed. Although the lateral margins of the middle half of the worm are usually convex, specimens are occasionally found, the sides of which are almost parallel, thus agreeing with *F. gigantea* in form.

The body is thickest (2-4.5 mm.) at about the position of the ventral sucker or just behind this organ. From this region the body grades quite rapidly and regularly to the mouth; posteriorly and laterally the body diminishes in thickness more gradually, at the margin becoming very thin.

Specimens sent to us by Prof. Sonsino, Italy, measured as follows:

Length.	Greatest Breadth.	Gen. pore from Anterior Extremity.	Acetabulum from Anterior Extremity.
mm.	mm.	mm.	mm.
72	28	4.75	8
60	18	3.5	5
59	24	4	7
55	24	4	6.5
57	22	4.5	7.5
48	21	3.75	7
34	20	3.5	5.5
27	10	3.5	5

In his article ('90) Sonsino records a specimen 100 mm. long.



PLATE II.—*F. magna*.

Sixteen specimens of different size, contour and stages of contraction. 1 All natural size. The mouth, genital pore and acetabulum are visible.

Specimens taken in this country presented the following measurements (made on preserved material):

Length.	Greatest Breadth.	Gen. pore from Anterior Extremity.	Acetabulum from Anterior Extremity.
mm.	mm.	mm.	mm.
23.5	19	1.5	3
26	11.5	2	3.5
26	17	2	4
32.5	17.5	3.5	6
34.5	19.5	2.5	5
35	14	3.5	7
35.5	18	2.5	5
37	16.5	2	3.5
39	24	3.5	7
42	13.5	2.5	5
42	14	2.5	5
45	23	2	4.5
49	17.5	3.5	7
56	22.5	4.5	9
59.5	25.5	3.5	6
73	26	4	8

Measurements by Francis are given as 30-73 mm. in length by 20-30 mm. in breadth. He found some specimens which were 8 mm. long by 4 mm. broad.

At the anterior extremity is the deep oral sucker, tending slightly ventrally; 1.5 mm.-4.75 mm. caudad of the same, in the median line, lies the genital pore, from which the cirrus frequently extrudes; 3-9 mm. (4-5 mm. after Francis) caudad of the mouth, in the ventral median line is the acetabulum. The latter is sometimes larger (2.5 mm.) than the oral sucker (1.5 mm.). Its opening varies between an equilateral triangle—the base anterior, the apex posterior—and a circle. Near the posterior margin of the body in the dorsal median line is found a small opening, the pore of the excretory canal.

Anatomy.—Almost the entire anatomy can be made out upon unpreserved specimens which are allowed to macerate a few days in water or in very weak alcohol. Such specimens are drawn on Plate I, Figs. 2 and 3, the digestive organs and sexual organs being shown in separate figures to avoid confusion.

It will be seen that the oral sucker is followed by a pharyngeal bulb, this in turn, by an œsophagus, which is generally from 1½-3 times as long as the bulb. The œsophagus then branches at

right angles like \perp into the two primary intestinal cæca immediately anterior to the genital pore. These primary branches, extend anteriorly nearly to the mouth, and posteriorly, one on each side of the median line, to the posterior extremity of the animal. Each intestinal branch sends off secondary branches, both towards the median line and the lateral margins. These secondary branches then give off smaller branches both anteriorly and posteriorly (Fig. A. and Plate I, Fig. 2). It will, however, be noticed that a space is frequently left in the median line which is not covered by these branches. I have counted from 16 to 25 lateral cæca and about the same number of median branches.

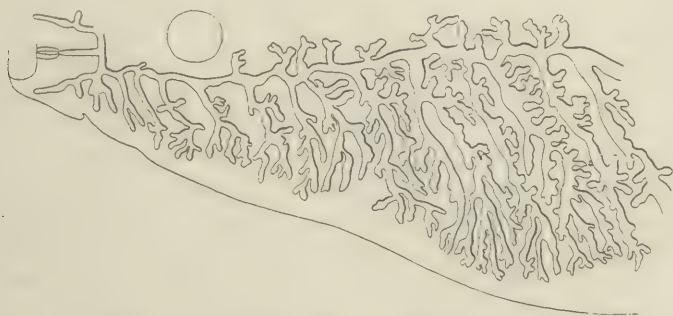


Fig. A. Outline of oral sucker, pharynx, œsophagus, anterior portion of right intestinal cæcum with its numerous branches, and acetabulum.

Male genitalia.—The cirrus (Plate I, Fig. 3) is generally quite prominent. The vasa deferentia are difficult to see. Two branched testicles lie, one on each side of the median line, in about the middle of the body, the right testicle being slightly posterior to the left testicle. In one specimen (Plate I, Fig. 3) examined, these testicles were entirely distinct from each other, a space remaining unoccupied by them in the median line. As a general rule, however, the right and left testicles cannot be distinctly separated from each other, for branches of each extend into the field of the other.

Female genitalia.—Vitellogene glands (Plate I, Fig. 3) occupy almost the entire marginal field, with the exception of the anterior conical portion of the body. The vitello-ducts can be traced for a short distance, one running from each side transversely towards the median line, at about the posterior border of the anterior third of the body. In the median line they meet in a common reservoir and enter the "shell-gland," which also receives the oviduct. The ovary is much whiter than the other organs, is quite ramified

and lies, in most cases that I have examined at least, on the right side of the body. From the shell-gland, the uterus can be traced to a point near the acetabulum.

Nerves.—Two ventral longitudinal nerves (Plate I, Fig. 3) can be seen running from the oral sucker, and diverging posteriorly. They can be traced to about the middle of the body.

It will be seen from this short description that the organization agrees very well with that of *F. hepatica*. In order to obtain further details one must have recourse to stained specimens, both press-preparations and microtome sections.

Cuticle.—The entire surface of the worm is covered with a cuticle, which extends into the various apertures (see below) of the body; it becomes much thicker on the ventral surface, and in the thick portions shows the palisade-like structure mentioned by Leuckart in *F. hepatica* (l. c., p. 186). It is pierced by numerous apertures, $9\ \mu$ or more in diameter, through each of which extrudes a spine (Plate I, Fig. 7). The spines are rather conical in shape, slightly curved, $42\ \mu$ – $52\ \mu$ long, $9\ \mu$ – $12\ \mu$ in diameter at the base; they extend down through the cuticle to the muscular layer, and possess a rather blunt apex which is directed caudad.

The *acetabulum* is 1.6 to 2.5 mm. in diameter; its muscular wall is 0.48 mm. in thickness. Its general structure agrees with that of *F. hepatica*.

The *muscles* lying directly under the investing cuticle of the body also agree with those described for *F. hepatica*, i. e., 1, the outer layer is composed of circular fibres; 2, the next layer of longitudinal fibres, and 3, the inner layer of a double set of diagonal fibres.

The only point I will mention in connection with the *parenchyma*, which appears to be the same in all allied forms, is that I have found a number of large cells near the surface of the body, which agree in appearance with the cells found by various authors in the acetabulum, oral sucker and pharyngeal bulb. Whether they really are identical in origin, I am unable to state; as to the function of these cells see below.

Digestive tract.—The oral sucker (Figs. B and C) measures 0.96 mm.–1.5 mm. in transverse section. Its longitudinal section measures 0.48 mm.; the muscular wall is 0.21 mm. thick. It is composed of the following:

1. A cuticle which lines its cavity.
2. A layer of muscular fibres which run parallel to its concave surface; in transverse section of the body, longitudinal sec-

tions of these fibres are seen, while in frontal sections of the body, transverse sections of the muscles come into view. This layer becomes much thicker nearer the pharynx.

3. A layer of muscular fibres of which the transverse sections

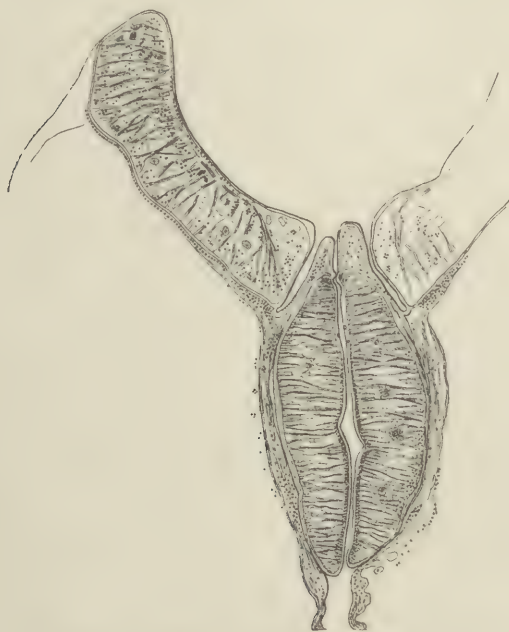


Fig. B. Longitudinal section of oral sucker, post-buccal ring and pharynx.

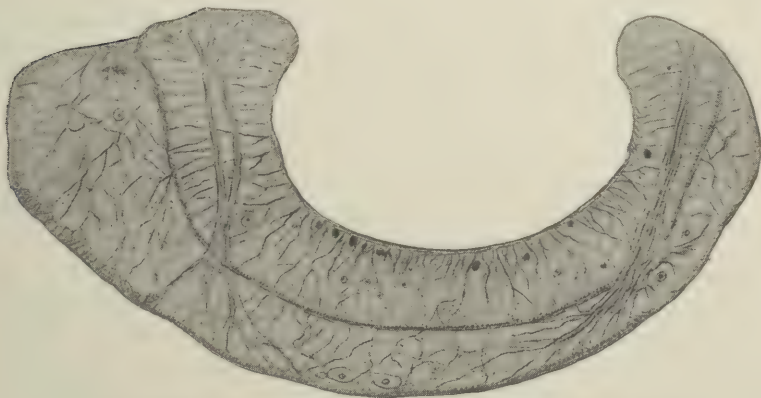


Fig. C. Transverse section of oral sucker. For description see text.

appear on transverse sections of the body, and longitudinal sections in frontal sections of the body. They too become heavier near the pharynx. Layers 2 and 3, running at right angles to each other, are evidently Leuckart's *æquatorial* and *meridional fibres*.

4. On each side of the median portion of the sucker there is quite a highly developed system of muscular fibres which are seen in cross section on frontal sections of the body and in longitudinal section on transverse and sagittal sections of the worm.

These fibres extend from the lateral margins (each side) around through about the middle of the muscular wall in such a way as to form almost a circular layer on each lateral third of the sucker, the median third of the sucker being free from them. The fibres then run dorsally, pierce the dorsal boundary of the sucker, scatter through the surrounding parenchyma of the body and insert on the dorsal portion of the worm. They are not evenly distributed in the sucker, but lie in bundles.

At the boundary between the sucker and the parenchyma of the body, are found two layers of muscles which cross each other at right angles.

5. Nearest the parenchyma is a layer which appears in transverse section on frontal sections, but *in toto* on transverse sections, the continuation of 2.

6. A layer inside of these (*i. e.*, nearer the opening of the sucker), which is a continuation of layer 3. The fibres appear *in toto* on frontal sections and as transverse sections in transverse sections of the sucker.

7. Extending between the two borders of the sucker are numerous radial muscles (*i. e.*, at about right angles to the cuticle).

Nerve-fibres also enter the sucker, and scattered through the latter are numerous small nuclei, as well as larger round and very peculiar nuclei, which various authors look upon as ganglion cells (Leuckart and others), or as connective tissue nuclei (Looss). Preparations stained with acid carmine speak decidedly in favor of the interpretation given by Looss.

As stated above, I have found in *F. magna* a number of nuclei very similar, perhaps identical with these in the parenchyma of the body near the muscular wall.

Leuckart's description of the pharynx of *F. hepatica* applies in a general way quite well to this species also. There are, however, some details in regard to which the description cannot be applied. Leuckart states that the pharynx is not entirely separated from the buccal sucker, but that the anterior end of the former is con-

nected with the latter for a short distance (l. c., fig. 101). I, however, find that both in this species and in *F. hepatica* the two organs are distinctly separated by the* post-buccal cavity (*Vorhöhle* of Leuckart). In transverse sections it frequently appears as if the pharynx and oral sucker were connected, but in frontal and sagittal sections the circular post-buccal cavity can always (*i. e.*, in my preparations) be distinctly seen separating the two. The pharynx of *F. magna* measures 0.8 mm. long. It is made up of the following:

1. A cuticle, in which remains of nuclei are occasionally found.
2. Numerous radial muscles which make up the greater part of the organ.
3. A layer of circular muscles next to the cuticle, seen in transverse section on frontal sections of the worm, *in toto* on transverse sections of the parasite. This layer is about $8\ \mu$ thick, except in the posterior portion of the bulb, where it increases to about $16\ \mu$.
4. Near the periphery of the pharynx is a layer of circular muscles. In the lateral portion of the bulb, these muscles are very close to the periphery, but they come quite close to the lumen on the dorsal and ventral surfaces.
5. Exterior to the circular muscles is found a heavy layer of longitudinal muscles. This layer appears thicker in the anterior portion than in the posterior portion.
6. There is a reticulum of parenchymatic appearance, extending throughout the entire organ, and here and there are seen large ($42\ \mu$) cells (nucleus $16\ \mu$, nucleolus $6\ \mu$), such as were mentioned in connection with the oral sucker.

The muscular wall of the pharynx is about 0.18 mm. thick; its dorso-ventral diameter is 0.770 mm., its lateral diameter 0.450 mm. These measurements are subject to a slight variation due to individual variation and contraction.

The entire bulb is surrounded by the *protractor pharyngis*, a series of muscular fibres which extend from the posterior end of the pharynx to the posterior portion of the post-buccal cavity, some of the fibres inserting in the oral sucker.

Post-buccal cavity (Fig. B).—Between the oral sucker and the pharynx is found a post-buccal ring. This is circular in form, is quite shallow at the lateral portion of the pharynx, but somewhat

* In all probability this difference between Leuckart's results and mine are, I believe, to be explained by slight individual variations.

deeper on its dorsal aspect and still deeper on its ventral aspect.*

The cuticle at the deepest portion of this ring is much thicker than at the upper portion, and has very much the appearance of an epithelium similar to that in the intestine. This is due to a splitting of the cuticle.

Œsophagus.—Judging from the published figures of *F. hepatica* authors are quite generally agreed that the œsophagus of that species is extremely short. In most cases it is drawn about equal in length to the pharynx, frequently shorter than the pharynx. In my own preparations it is generally equal to or shorter than the pharynx, but in a few cases it is longer than that organ. In *F. magna*, on the other hand, the œsophagus (Fig. A) is from $1\frac{1}{2}$ to 3 times as long as the pharynx, averaging about 1.4 mm. long. It is 0.26 mm. in diameter. Its component parts are: 1, a lining cuticle; 2, a layer of circular muscle-fibres, and 3, a layer of longitudinal fibres. The layer of circular muscles is thickest very close to the pharynx. Posteriorly, the œsophagus branches, sending a prolongation at nearly right angles to each of the intestines.



Fig. D. Transverse section of body to show the intestines.

Intestine.—The intestine proper (Fig. A, and Plate I, Fig. 2) bears a close resemblance to the intestine of *F. hepatica*. The two longitudinal canals give off numerous branches as described above. On transverse sections (Fig. D) it will be noticed that

*This is another point where my results differ from Leuckart's. Leuckart states that the post-buccal ring is deeper dorsally than ventrally, and that a pouch is present ventrally. Mehlis (according to Leuckart) considered this pouch as a portion of the post-buccal ring, but Leuckart himself looks upon it as an independent organ. Of some ten different series of sections of *F. hepatica* and *F. magna* only one of them seem to support Leuckart's view, and even the pictures yielded by this series permitted another interpretation. The remaining series certainly supported the view advanced by Mehlis. That there should be this difference between Leuckart's description of *F. hepatica* and mine of *F. magna* is not so strange, but that my series of *F. hepatica* do not support Leuckart's description seems rather peculiar to me. The matter finally resolves itself to the point that either I and Mehlis are in error, or Leuckart is in error, in the interpretation of our slides, or that here too there may be an individual variation.

the various tubes have a semi-lunar arrangement, the concavity being directed ventrad. The histology agrees with that of *F. hepatica*. The high columnar epithelium bounds the lumen, the cells resting upon a thin membrane; this, in turn, is surrounded by longitudinal and circular muscle-fibres. The arrangement of these fibres does not appear to be constant. While the order described by Leuckart, circular fibres between two layers of longitudinal fibres, is frequently distinguishable, it not infrequently occurs that the circular fibres are outermost.

Nervous system.—The nervous system (Fig. E) does not differ materially from that of *F. hepatica*. On each side of the anterior portion of the pharynx there is situated a large ganglionic mass; the two ganglia are connected by a commissure crossing the pharynx dorsally. From the anterior point of these ganglia a ventral

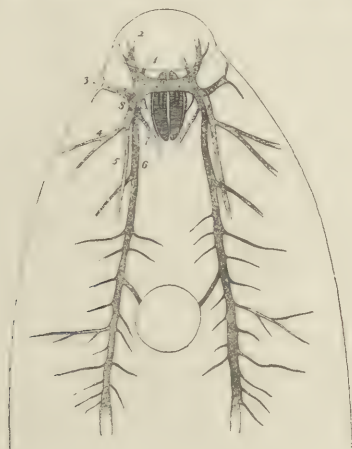


Fig. E. Nervous system, for description see text.

nerve (1) runs to the oral sucker. Just dorsally of these nerves a pair of nerves (2) branches to the anterior portion above the sucker. The third pair of nerves (3) extends laterally and anteriorly. The fourth pair (4) extends laterally and posteriorly and then branches. Immediately dorsal of this pair, a longitudinal dorsal nerve (5) extends posteriorly to about the position of the ventral sucker. Median and ventrally of this, a large ventral nerve (6) extends posteriorly and gives off branches both towards the median line and towards the sides of the animal. From a point anterior and median of the origin of these ventral nerves a seventh (7) pair of nerves runs medio-ventrally to a position ventrad and very slightly posterior to the pharynx, where they

unite in a common ganglionic mass. The eighth pair of nerves (8) is anterior to this point and supplies the pharynx.

Genital organs.—The genital pore, as stated above, lies immediately ventrad and posterior to the bifurcation of the œsophagus. On the right is the cirrus, on the left the vulva.

Male genitalia.—The cirrus, as is the case with *F. hepatica*, is sometimes extruded and resembles a narrow tongue in form, sometimes inverted in the cirrus-pouch. Its lumen empties into a ductus ejaculatorius which widens into the vesicula seminalis, into the posterior end of which the two vasa deferentia open. The latter then extend caudad passing dorsally of the uterus. When the uterus becomes longer some of its loops extend around dorsally of the vas deferens.

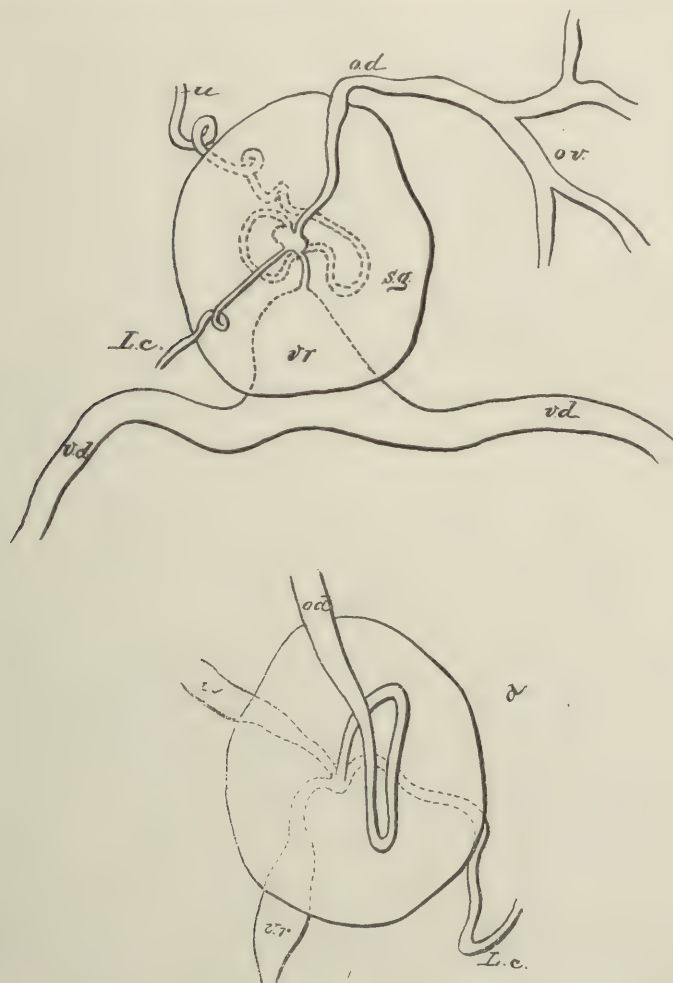
In nearly all published figures of *F. hepatica* the vasa deferentia cross the vitello-ducts dorsally, but in all of my preparations, both of *F. hepatica* and *F. magna*, the vasa deferentia cross the vitello-ducts ventrally. The vas deferens on the same side of the body as the ovary runs dorsally of the latter.

The vas deferens of the right side extends slightly further caudad than that of the left side. Both vasa deferentia branch into the testicular canals which give off numerous secondary canals. These testicular canals cross each other, forming an irregular network. In many places they seem to anastomose, in other places it is difficult to decide whether they cross each other or anastomose. The testicles have an extreme ventral position.

Histology.—The inverted cirrus shows the following structure: 1, canal, $21\ \mu$ in diameter; 2, cuticle, $12\ \mu$ thick; 3, heavy layer of circular muscles; 4, longitudinal muscle-fibres. The narrow portion of the ductus ejaculatorius is lined with a thin cuticle under which lies an epithelium, followed by circular and longitudinal muscles. In the vesicula seminalis the cuticle almost disappears. While the ends of the epithelial cells of the narrower portion are very irregular and extend down into the muscular layer, in the vesicula seminalis the epithelial cells become more regular in outline. The muscular portion becomes thinner. The vasa deferentia empty into the vesicula seminalis sometimes within the cirrus-pouch, sometimes slightly caudad of the same. In the muscular wall of the cirrus-pouch can be distinguished circular, longitudinal and irregularly diagonal fibres. The space between the muscular wall and the inner canal (v. s., etc.) is occupied by gland-cells and a connective tissue.

Female Genitalia.—The vulva is situated at the left of the

cirrus; it is lined by an invagination of the cuticle, this in turn being surrounded by circular and longitudinal muscles. A canal can be traced from the vulva to the middle of the shell-gland, presenting a somewhat different appearance in its different portions. The first portion is generally rather narrow and presents a cuticle, heavy circular muscles and longitudinal muscles. This serves as the vagina, sometimes it contains eggs and is very broad.



Figs. F and G. Two outlines of the shell gland (s. g.), with ovary (ov.), oviduct (od.), uterus (u.), Laurer's canal (L. c.), vitelline reservoir (v. r.), and vitello-ducts (v. d.). Fig. F, frontal projection; Fig. G, sagittal projection.

The vagina extends on the left of the cirrus-pouch, gradually coming to lie ventrally of it. As transverse sections are followed caudad, it is noticed that the lining of the canal becomes raised at a number of points, the raised portion resembling columnar cells, but possessing no nuclei. At a point over the middle of the acetabulum the lining becomes distinctly cellular, the nuclei coming plainly into view.

From this point on, the uterus extends in a number of loops posteriorly, possessing the same histology, *i. e.*, cylinder epithelium, circular and longitudinal muscles. At a point ventral of the shell-gland it turns dorsally and enters the latter, winding irregularly, until it reaches the center. The last portion (Figs. F-G) in the shell-gland, is frequently very much narrower. In this portion the circular muscles are still visible.

In the center of the so-called shell-gland, is a short canal (*Centralraum*) running dorso-ventrally, and into this open four canals, *i. e.*, the vitello-duct, oviduct, Laurer's canal and uterus. The topographical relations of these canals vary slightly in different specimens. In general, however, they present the same relations which Leuckart has figured for *F. hepatica* (l.c., Fig. 113). On sagittal sections (combined) they present the relation shown in Fig. G. Here it will be noticed that the vitello-duct and the uterus enter the shell-gland ventrally, while the oviduct and Laurer's canal lie dorsally. The oviduct, Laurer's canal, and the vitello-duct enter the central chamber near each other at one end (dorsal), while the uterus extends from the other (ventral) end. As stated above, the relative position of the canals is subject to variation.

Laurer's canal has been the subject of much speculation on the part of various workers, most authors homologizing it with the vagina of **Bothriocephalus*. According to a view recently advanced by Looss, however, Laurer's canal is homologous with the uterus of cestodes. Looss' interpretation seems to be the best one which has yet been suggested.

It would be beyond the object of this article to describe minutely the histology of these various organs. Suffice it to say that the central chamber (*Centralraum*) possesses a very distinct epithelium (nuclei 3-4 μ) with a basement membrane (or muscles?). The Laurer's canal has a heavy cuticular lining, which varies in

*For a discussion of this subject vide: Leuckart, *Die Parasiten des Menschen* I. 2. pp. 55-60; Braun's *Vermes*; Looss, *Ist der Laurer'sche Kanal der Trematoden eine Vagina?* (C. f. B. u. P. XIII. pp. 808-819.)

thickness according to the diameter of the lumen. This cuticle is surrounded by a thin circular layer which is possibly muscular in nature; this, in turn, by a mass of tissue in which nuclei are more or less regularly distributed. In the lower portion of the uterus, one finds ova with the forming egg-shells, vitellene cells, and a mass of yellowish matter. Authors generally assume that this yellowish matter forms the shell and is itself the product of the shell-gland (Leuckart). Leuckart adds (l. c., p. 232): "Ich meinerseits bin gleichfalls der Ansicht, dass diese Massen den Drüsenzellen entstammen, glaube aber, die gelbe Farbe derselben auf die Dotterzellen zurückführen zu müssen, welche nach dem Uebertritt in die weiblichen Leitungswege die in sie eingelagerten gelben Körner mehr oder minder vollständig verlieren und nach aussen hervortreten lassen, so dass diese dann mit dem an sich farblosen Secrete der Schalendrüsen verschmelzen können. So viel ist jedenfalls gewiss, dass der Inhalt der Schalendrüse niemals gelb gefärbt ist."

My study of *F. hepatica* and *F. magna* would lead me to go even a step further than Leuckart. I believe that altogether too much importance has been attached to the shell-gland and too little to the vitellogene glands, in regard to the formation of the egg-shell. In fact, I believe that almost the entire material for the egg-shell is furnished by the vitellene cells. In support of this view I will present the following observations. The vitellene cells, while still in the vitellogene glands, in the vitello-ducts and the vitello-reservoir, are charged with small and large yellowish globules. As the cells ascend from the vitellogene glands to the central chamber of the shell-gland, either many of these globules must be excreted from the cells or many of the cells must perish, thus setting the globules free, for the vitello-ducts, etc., contain numerous smaller or larger globules of yellowish matter, which are exactly similar to those found in the lower portion of the uterus during the process of formation of the egg-shells. It must be remembered that these free globules are numerous even before the vitellene cells have entered the shell-gland; in fact, many may be found in the beginning of the vitello-duct or even in the vitellogene glands.

As the vitellene cells join the ova, the yellowish globules disappear from the former almost entirely and become more numerous in the lumen of the uterus, and all gradations can be found, between a minute yellowish globule and an entire egg-shell, so that it seems to me certain that the yellowish matter formed by the vitellene cells enters directly into the composition of the egg-shell.

Whatever secretion is formed by the shell-gland is certainly colorless, as Leuckart states.

If this interpretation is correct, then the function of the shell-gland would probably be to secrete a fluid which would act upon the yellowish particles and render them more plastic.

In regard to the vitellogene glands, it is worthy of note that while they extend both dorsally and ventrally of the intestines in *F. hepatica*, in every specimen of *F. magna* which I have examined, they are confined almost entirely to the ventral side of the intestines, although here and there a branch extends dorsally.

Excretory apparatus.—The excretory apparatus agrees essentially with that of *F. hepatica*. It runs dorsally of the intestines.

Ova.—(Plate I, Figs. 4-5). The eggs of *F. magna* can hardly be distinguished from those of *F. hepatica*; in general, however, they are slightly larger than the measurements given for *F. hepatica*, as will be seen by the following table:

<i>F. magna.</i>		<i>F. hepatica.</i>	
Long.	Broad.	Long.	Broad.
mm.	mm.	mm.	mm.
0.109-0.168	0.075-0.096	0.105-0.145 0.13-0.14 0.13-0.172	0.066-0.090 (R. Blanchard) 0.075-0.09 (R. Leuckart) 0.072-0.08 *(Stiles)

The *Miracidium* (Plate I, Fig. 6).—On several different occasions I have raised the embryos of this species from eggs, sent from Chicago by Dr. Melvin, from Arkansas by Dr. Dinwiddie, or collected at Washington by Dr. Hassall. Like the miracidium of *F. hepatica* it is covered with a ciliated epithelium. On the anterior end is found a papilla in which an opening is perfectly visible. This opening leads into a thin string of tissue, evidently a rudimentary œsophagus, ending in a double-lobed body which, from analogy with *F. hepatica*, represents the rudimentary intestine. Immediately posterior to this, is situated the ganglionic mass with the two cup-shaped eyes. In the posterior portion of the body a number of germ-cells can be distinguished. All of these observations were made upon living specimens, and as the

* American specimens.

similarity with the miracidium of *F. hepatica* is so striking, it was not deemed necessary—for the purpose of this paper—to prepare microtome sections of this stage.

The ciliated organism swims around rapidly in the water, changing its form as quickly and as much as does the miracidium of *F. hepatica*. A detailed description of these movements would simply be a repetition of the description of *F. hepatica* given by Leuckart and Thomas. The measurements naturally change with the change of form; in general, however, the miracidium agrees in size very well with the miracidium of *F. hepatica*, i.e., 0.15 mm. long by 0.04 mm. broad, the posterior extremity being narrower than the anterior.

Later stages.—From the similarity between the anatomy of *F. hepatica* and *F. magna* it may be confidently expected that the life-history of the large American fluke will be very similar to that of *F. hepatica*, as determined by the investigations of Leuckart and Thomas. Experiments to raise the different stages are now in progress in the laboratory, and it is hoped that some positive results may soon be reported. It is, however, difficult to procure the proper intermediate host of the parasite so far from the locality where the organism lives, and it may be necessary to carry on the experiments in Texas or Arkansas, before the entire life-cycle can be demonstrated.

SPECIFIC DIAGNOSIS.

F. magna (Bassi, 1875) Stiles, 1894.—The flesh-colored body is much larger and thicker than *F. hepatica*, measuring 23-100 mm. long by 11-26 mm. broad by 2-4.5 mm. thick. The anterior portion is not so distinctly separated from the posterior portion. The margin is more convex and the posterior extremity is bluntly rounded. The ventral surface is convex and much darker than the flat dorsal surface. The general organization is very similar to that of *F. hepatica*, but the œsophagus is generally longer in proportion to the pharynx, the intestines are more ramified, and the vitellogene glands are confined almost entirely to the ventral side of the intestines. Eggs measure 109-168 μ long by 75-96 μ broad.

To be continued.

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THE ANATOMY OF THE LARGE AMERICAN FLUKE
(*FASCIOLA MAGNA*), AND A COMPARISON
WITH OTHER SPECIES OF THE
GENUS *FASCIOLA*, S.ST.

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CONTAINING ALSO A LIST OF THE CHIEF EPIZOÖTICS OF
FASCIOLIASIS (DISTOMATOSIS) AND A BIBLIOGRAPHY
OF *FASCIOLA HEPATICA*.

BY ALBERT HASSALL, M.R.C.V.S.

(Continued from page 243.)

II. *Fasciola hepatica* L., 1746 et 1758.

PLATE III.

This species has been so carefully studied by so many authors that it is useless to repeat the details of the anatomy in this paper. It will suffice for present purposes if the synonymy, hosts, geographical distribution, literature, specific diagnosis and descriptions of the intermediate hosts are given.



PLATE III.

FASCIOLA HEPATICA L.

Fig. 1. American specimen of *F. hepatica* from cattle. Stained preparation to show the internal anatomy. The intestinal system can be seen only in the anterior conical portion. The genital organs can be made out by comparing this figure with Plate I, Fig. 3. In the latter figure, however, the ovary is dextral, in this figure it is sinistral.

SYNONYMY:

- 1746 et 1758, *Fasciola hepatica* L.;
- 1782, *Planaria latiuscula* Goeze;
- 1786, *Distoma hepaticum* Abildg ;
- 1789, *F. humana* Gmelin;
- 1803, *F. lanceolata* Rud.;
- 1845, *Distoma* (*Cladocœlium*) *hepaticum* Duj.;
- 1845, *Fasciolaria hepatica* (Anonymous);
- 1884, *Distomata hominis* Taylor;
- 1889, *Distomum* (*Fasciola*) *hepaticum* R. Lkt.;
- 1890, *D. caviæ* Sons ;
- 1892, *Cladocœlium hepaticum* Stossich.

COMMON NAMES:

- English —The common liver-fluke, liver-fluke;
- German—Leberegel, Leberwurm, Schafegel;
- Dutch —Botten, Leverworm;
- Danish—Faareflynder;
- Swedish —Levermask;
- French—Douve hepatique, fasciole;
- Italian—Biscuola, distoma epatico;
- Spanish—Caracolillo.

HOSTS:

- Man (*Homo sapiens*);
- Common European squirrel (*Sciurus vulgaris*);
- European beaver (*Castor fiber*);
- Tame rabbit (*Lepus cuniculus domesticus*);
- Wild rabbit (*L. cuniculus ferus*);
- Hare (*L. timidus*);
- Cat (*Felis domestica*);
- Swine (*Sus scrofa*);
- Egyptian buffalo (*Bos bubalus*);
- Cattle (*B. taurus*);
- Argale sheep (*Ovis argali*);
- Domestic sheep (*O. aries*);
- Goat (*Capra hircus*);
- Gazelle (*Gazella dorcas*);
- Roe deer (*Capreolus caprea*);
- Fallow deer (*Cervus dama*);
- Stag (*Cervus elaphus*);
- Blue bull (*Bos ~~aphus~~ tragocamelus*);
- Virginian deer (*Cariacus virginianus*);

la

Bactrian camel (*Camelus bactrianus*);
 Ass (*Equus asinus*);
 Horse (*E. caballus*);
 Sword-fish (*Orca gladiator*);*
 Great gray kangaroo (*Macropus giganteus*).

*Leuckart once gave me two specimens of a fluke, which I still have in my possession, labelled "Leber, Schwert-fisch." I am unable to distinguish this fluke from *F. hepatica*. I assume that this "Schwert fisch" is *Orca gladiator* rather than *Xiphias gladius*, as all the other hosts of *F. hepatica* are mammals.

GEOGRAPHICAL DISTRIBUTION.—This species is almost cosmopolitan, being recorded from all the countries of Europe; Asia (India); Africa; Australia; Sandwich Islands; South America (Buenos Ayres and elsewhere). In North America we have positive proof of its occurrence in Long Island, N. Y. (Law); Chicago, Ill, cattle came from Texas (Stiles); California (Curtice); Arkansas (Dinwiddie); Texas (Francis, Detmers); Louisiana (Wheeler). "Rot" is recorded in many other localities, but the term "Rot" in American literature covers a multitude of diseases.

SPECIFIC DIAGNOSIS.

F. hepatica L. 1746 et 1758.—Body pale brown, leaf-like, flattened, 18-51 mm. long by 4-13 mm. broad; the anterior 3-4 mm. forms a rather thick, conical portion which is followed by a large, flat, leaf-like body of elongate-oval form; this latter widens rapidly to the maximum breadth and then decreases gradually in width to the posterior end which is bluntly pointed; cuticle is covered with numerous spines placed side by side in alternating rows; oral sucker is anterior, round and terminal, but inclines ventrad; acetabulum about 3-4 mm. caudad of oral sucker, with which it closely agrees in size; genital pore median, about half way between oral sucker and acetabulum; œsophagus rarely over 1.1½ times as long as the pharynx; intestine dendritic; cirrus frequently extruded from pore and then recurved; testicles profusely branched, situated for the greater part posterior to transverse vitello-duct. Vulva at side of cirrus; uterus forms a rosette with its numerous coils, and is frequently visible to the naked eye as a dark brown spot immediately posterior to the acetabulum; ovary branched, anterior of transverse vitello-duct; vitellogene glands profusely branched, and occupy the entire margin of the body from acetabulum to posterior extremity; they lie dorsally as well as ventrally of the intestine, becoming wider posteriorly. Oviparous.

Eggs oval, 0.13-0.14 mm. long by 0.075-0.09 mm. broad; *miracidium* conical, ciliated, with oral papilla, two cup-shaped eyespots, and rudimentary intestine; metamorphosis (sporocyst, redia, cercaria) takes place in small snails of the genus *Limnæa* (*L. truncatula* and others); *cercaria* whitish, owing to excessive development of the capsule glands; encysts upon plants.

THE INTERMEDIATE HOSTS OF *F. HEPATICA*.

PLATE IV.

It was shown by Leuckart and Thomas that in Europe the intermediate host for this fluke is a small swamp-snail, *Limnæa truncatula*; Leuckart also showed that the rediæ (but not the cercariæ) would develop in the young of another species of snail, *L. peregra*, and quite recently Lutz ('92 and '93) has shown that in Oahu and Kani (Sandwich Islands) two other snails may serve in this capacity, *i. e.*, *L. oahuensis* Souleyet and *L. rubella* Lea. In the case of *L. oahuensis*, Lutz states that "the infection can take place only in young specimens." None of these four very closely allied species are recorded for America, and yet we find *F. hepatica* in both North and South America, so that we must either have on this continent some other species of snail which may act as intermediate host, or some of the species described in America must be identical with some of the above-named forms.

The forms which would especially fall under suspicion are *L. humilis* Say in North America, and *L. viator* Orb. in South America.

This report is not the place to discuss the question as to whether *L. truncatula*, *L. peregra*, *L. oahuensis*, *L. rubella*, *L. humilis* and *L. viator* represent six well established species or not, as that is a matter for conchologists to decide; suffice it to say that specialists in conchology have described snails under these names; that the forms are all so very closely related, that a zoölogist would not commit a very grave offense against systematic zoölogy if he were to consider them as varieties of two or three species; that the forms described under the names *L. truncatula*, *L. oahuensis* and *L. rubella* are known to serve as intermediate host for the parasite now under discussion; that in Europe the rediæ (but not the cercariæ) develop in *L. peregra* and that it is probable, though not demonstrated as yet, that *L. humilis* is intermediate host for North America and *L. viator* for South America.

As these snails form the intermediate host of a dangerous, in



PLATE IV.

INTERMEDIATE HOSTS OF FASCIOLA HEPATICA.

- Figs. 1 a-c. *Limnæa oahuensis*, after Souleyet. Fig. c nat. size, a-b enlarged.
 Figs. 2 a-c. *L. viator*, after d'Orbigny. Nat. size and enlarged.
 Figs. 3 a-b. *L. peregra*, after Lkt. Nat. size and enlarged.
 Figs. 4 a-b. *L. truncatula*, after Lkt. Nat. size and enlarged.
 Figs. 5 a-j. *L. humilis*, after Binney. Nat. size and enlarged.

many cases fatal parasite, they must be included among the worst enemies of the stock-raiser. On that account, and since our experiments with *F. magna* will be greatly influenced by the facts known in regard to the development of *F. hepatica*, the intermediate hosts in all probability being closely allied animals, it has been thought best to give the descriptions, etc., of all the snails which are known or supposed to act as intermediate hosts for *F. hepatica*.

The systematic position, and at the same time a certain amount of the anatomy of these mollusks may be seen from the following synopsis, based upon the writings of Gray ('57), Binney ('65), Souleyet ('52), Lea ('41), Jeffreys ('62), d'Orbigny ('35), Westerlund ('85) and others

J. E. Gray.—Manual of the Land and Fresh-Water Shells of the British Islands. London, 1857.

W. G. Binney.—Land and Fresh Water Shells of North America. Part II. Smithsonian Misc Collections, 143. Washington, 1865.

Souleyet.—Voyage autour du Mond. sur la Corvette La Bonite. Vol. II. 1852.

Lea.—On Fresh Water and Land Shells; Proc. American Phil. Soc. 1841.

Jeffreys.—British Conchology. Vol. I. 1862.

d'Orbigny.—Voyage dans L'Amerique Méridionale, 1835-1843.

C. A. Westerlund.—Fauna der in der Paläarctischen Region lebenden Binnenconchylien. II. 1885.

MOLLUSCA.—Class **GASTROPODA.** Mollusks with a distinct head, which is generally provided with tentacles and eyes; provided with a single median muscular foot with a broad sole, (*seldom with a laterally compressed fin or heel-like foot); the undivided mantle frequently secretes a spirally twisted (or plate-shaped shell); pallial cavity lateral and dorsal; mouth with jaws and tongue; respiration through lungs (or gills); hermaphroditic (or diœcious).

Order, PULMONATA.—Land or fresh water snails, (naked or) with shells; palial cavity lies on right side, as a rule anterior to heart, and is arranged for breathing air; true operculum absent; hermaphrodites.

Sub-order, BASOMMATOPHORA.—Eyes on the median side or at the base of the tentacles; tentacles can be contracted but not invaginated; labial tentacles absent; a well-developed external shell always present; genital openings separated.

"LIMNÆADÆ.—Animal with an elongate foot, a more or less conical spiral body, a short muzzle, with dilated lips and compressed tentacles, with the eyes near the inner side of their base;

*Statements in parentheses do not apply to *Limnæa*.

the mantle, which covers the body, has a thin edge and is protected by a variably shaped pale uniform colored shell, which is clothed with a hard olive periostracum" (Gray p. 196). Genital openings close to each other, the male opening nearer the tentacles. the female opening nearer the breathing pore; jaw composed of one or of several—3—pieces.

"They live in ponds and ditches, often floating on the surface of the water, their back downwards, or crawling on the mud at the bottom, or on aquatic plants, but always coming to the surface to respire." (Gray p. 196.)

"The family contains nine genera, which may be thus distinguished:

- a. Shell ovate, spiral; pillar with an oblique plait.
 - 1. *Limnæus* [*Limnæa*]. Shell rough; inner lip simple.
 - 2. *Amphipeplea*. Shell polished, thin; inner lip expanded.
- b. Shell conical, recurved; apex oblique.
 - 3. *Ancylus*. Apex of the shell to the right.
 - 4. *Velletia*. Apex of the shell to the left.
- c. Shell ovate, sub-spiral; pillar smooth.
 - 5. *Otina*.
- d. Shell ovate, spiral; pillar simple.
 - 6. *Physa*. Inner lip expanded.
 - 7. *Aplexus*. Inner lip not expanded.
- e. Shell discoidal.
 - 8. *Planorbis*. Cavity of shell simple; mouth roundish or sub-quadrate.
 - 9. *Segmentina*. Cavity of shell divided by cross septa; mouth triangular.

"Tentacles short, compressed, triangular, without any auricle at the base; jaws 3, smooth; shell oblong, spiral. (*Limnæana*.)

1. LIMNÆA* (Mud Shell). "Animal with a short broad foot, broad short compressed tentacles, without any auricles at the base, a large upper and two small rudimentary lateral jaws, a large central spiral body, and a simple-edged mantle, covered by an external ovate, thin, dextral, transparent spiral-shell with an ovate mouth, having a single oblique plait on the middle of the column running into the axis.

"*Limnæa* has a small central tooth, as it were squeezed up between two very large lateral ones, each primary lateral having a very large apex internally, with a small external one, while at the edge they have altered to one thick prolonged apex projecting inwards and irregularly lobed on its upper edge." Gray, p. 199.

"The apex of the shell is often eroded or truncated; that is to

*The generic name has been spelt by authors in no less than nine different ways; but the correct orthography is undoubtedly *Limnæa* (from *λιμναῖος*—inhabiting marshes) as proposed by Rang.—Jeffreys, p. 101.

say, as the upper part of the body is withdrawn from the tip, and the body moves forwards into the larger part of the shell, it forms a septum behind, and the part that is thus separated eventually falls off." Gray, p. 200.

The *Limnæi* principally feed on the slimy matter which covers sticks, shells, and stones, beneath the water and on the mud, which is constantly found in the intestines. (Haldemann.)

Generic diagnoses of the genus *Limnæa* given by other authors differ slightly from the one just quoted; Gray's description will answer for all practical purposes, but as a comparison, and as the most recently revised diagnosis of the genus, the following is added from Westerlund ('85).

Gen. *Limnæa* (Brug.) Rang. Thier dick, Mundlappen vorn ausgerandet; die zwei Fühler zus.-gedrückt, dreieckig, kurz, mit den Augen innen an der Basis; Fuss keilfg., vorn abgestutzt, hinten spitz zugerundet; Mantel ganz eingeschlossen; Kiefer hornig, dreitheilig, mit breitem Mittelstücke u. schmalen, etwas gebogenen Seitenstücken; Zunge blattartig, vorn breit, hinten zus.-gelegt; die Mittelzähne s. klein, mit zwei Nebenhäckchen, die zahlreichen Seitenzähne grösser u. gesägt.

Gehäuse meist dünnchalig, mit Nabelspalt, ohrfg. o. eirund bis thurm o. spindelfg.; Umg. schnell zunehmend, der letzte oft s. weit u. fast das ganze Geh bildend, dann das Gew. s. kurz, o. Gew. lang thurmfg. ausgezogen; Mund. weit, gerundet bis länglich eifg., Spindelsäule oft frei hervortretend, bogig, Spindelumschlag lamellenartig, anliegend, Mundsaum einfach, scharf.

Syn. 1753 *Auricula* Klein—1758 *Helix* pr. p. L.—1774 *Buccinum* pr. p. Müller—1778 *Turbo* pr. p. Da Costa—1791 *Lymnea* Brug.—1799. *Lymnæa* Lam.—1801 *Limneus* Drap.—1810 *Lymnus* Montf.—1815 *Lymneus* Biard.—1817 *Limnæus* Cuv.—1826 *Limnea* Desh.—1829 *Limnæa* Rang --1841 *Lymnæus* Villa.

Subgenera:—

1. *Lymnus* Montf. Geh. festschalig, verlängert-eifg., mit gethürmtem, s. spitzem Gew., das meist von der Mündungslänge ist o. länger; Umg. typisch bei reifen Ex. 7-8, s. wenig gewölbt, anfangs langsam, dann s. rasch zunehmend, der letzte gross, aufgeblasen, m. o. w. ausgezogen.—Sp. 1.

2. *Gulnaria* Leach. Geh. meistens dünnchalig, mit kurzem o. sehr kurzem, öfters zugespitztem Gew.; Umg. 4-5, der letzte s. gross u. aufgeblasen, den weitaus grössten Theil des Geh. einnehmend. Münd. s. gross, gerundet,—selten Geh. festschalig, eifg., mit kegelförmigem Gew. u. spitzeiförmiger oft weissgelippter Münd., Umg. 4-5, der letzte nur convex.—Sp. 2-6.

3. *Limnophysa* Fitz. Geh. meist dickschalig, verlängert eifg., mit konischen o. thurmfgem Gew., das meistens länger. zuweilen viel länger als die Münd. ist. Umg. 7-8, langsam zunehmend, der letzte ausgezogen, wenig gewölbt; Münd. meist mit zweifarbigter (nach innen weisser, nach aussen rothbrauner) Lippe.—Sp. 7.

4. *Leptolimnea* Swains. Geh. cylindrisch-thurmfg. Umg. 7-8, s. langsam zunehmend; Münd. klein, kaum ein Drittel der Gehäuselänge, innen meist mit glänzend weisser Lippe.—Sp. 8.

5. *Fossaria* W. Geh. klein, länglich-eifg., dünnchalig, mit m. o. w. offenem Nabelspalte; Gew. spitzkegelfg., etwas länger als die Münd.; Umg. 5-6, s. langsam

zunehmend, stark gewölbt, der letzte meist auffallend weiter als die übrigen; Naht tief eingeschnürt.—Sp. 9-II.

6. *Tanousia* Bgt. Geh. klein, gedrunken, konischeifg., mit dem letzten Umg. erst s. aufgeblasen, dann allmählig verschmächtigt dass die Münd. s. eng wird; Münd. innen mit einer zus. hängenden Lippe.—Sp. 12. Westerlund p. 23-24.

1. *Limnæa truncatula** (Müller). Pl. IV, Fig. 4. "Body dark brown or grey, of a lighter color on the lower side, covered with fine black specks, tentacles short, but slender, rounded at their tips; eyes nearly sessile: foot rather short, marked with milk-white spots, which are scattered and larger than the black specks, nearly truncate in front, gradually narrowing and abruptly rounded behind.

"Shell oblong-conic, turretted, rather solid for its size, glossy, yellowish-brown or horn colour; epidermis thin: whorls 5-6, rounded and convex, but compressed in the middle, so as to make the top of each appear somewhat truncate; the last whorl occupying about three-fifths of the shell: spire abruptly tapering to a rather fine point: suture extremely deep: mouth oval, scarcely contracted on the inner side: outer lip sharp: inner lip continuous with it and reflected on the columella, behind which is a distinct umbilical chink: fold rather slight but thick. L. 0.4. B. 0.2. (in)" (3.5-1.5 mm. long by 1.8-5 mm. broad).

"Var. 1. *major*. Shell larger: whorls more swollen and the last considerably exceeding the usual proportion of size.

"Var. 2. *elegans*. Shell much larger, more solid and slender, greyish-white, marked with coarse spiral ridges: spire much produced: suture oblique: outer lip thickened. L. 0.6. B. 0.225" (in). (15 mm. long by 5 mm. broad).

"Var. 3. *minor*. Shell much smaller, thinner and semi-transparent, dark horn colour, marked with stronger and closer longitudinal striæ. L. 0.285. B. 0.165." (in) (7 mm. long by 4 mm. broad).

"Var. 4. *albida*. Shell smaller and white "

"Var. 5. *scalariformis*. Shell smaller: whorls nearly disunited."

"Var. 6. *microstoma*. Shell smaller and narrower: whorls more swollen: mouth contracted." J. G. Jeffreys. '87. I. pp. 115-117.

This snail is found on the banks of slow and muddy rivers and streams, marshes, ditches, etc. It is nearly amphibious in its

* Synonymy:—*Buccinum truncatulum* Müller; *Helix fossaria*; *Lymnæus minutus* Drap.; *Lymnæus fossarius*; *Limnæa fossaria*; *Limnæus minutus*; *Limnæa truncatula*.

Westerlund gives the following specific description recognizing 25 varieties:—

L. (Fossaria) truncatula. Geh. dünn, feingestreift, horn-braun; Umg. m. o. w. wendeltreppenartig abgesetzt; Münd. eifg., oben stumpfeckig, in der Regel kürzer als das Gew., Mündungswand s. quer, Spindel fast gerade herabsteigend, Munds. gerade. G. 9: 4, M. 4 mm. (Europa, Nordafrika, Nord. u. Westasien).

habits, being found more frequently out of the water than in it. It deposits its spawn on the mud, which it generally inhabits, and not like its congeners on stalks and under the leaves of water-plants. It is found from Siberia to Algeria and Sicily, occasionally in elevated spots.

2. *L. peregra** (Müller). Puddle Mud Shell (Pl. IV, Fig. 3). "Body yellowish-grey, with a brown or olive green tinge, mottled with black and covered with small yellow or milk-white, and black specks: tentacles diverging from each other at nearly a right angle: eyes distinct: foot oblong, very broad, nearly truncate in front, and obtusely rounded behind."

"Shell obliquely ovate, thin, moderately glossy, semi-transparent, yellowish-horn colour, irregularly striate by the lines of growth, and closely and microscopically striate in a spiral direction, with occasionally a few indistinct spiral ridges and pitmarks: epidermis rather thin: whorls 5, convex, the last occupying three-fourths of the shell: spire produced and pointed: suture rather deep: mouth large, oval, very little contracted above by the projection of the penultimate whorl: outer lip thin, slightly reflected: inner lip folded on the columella and thickened, forming behind it a slight umbilical cleft: fold rather prominent and curved. L. o. 75. B. o.425. (in.)" (8-20 mm. long by 4-10 mm. broad).

"Var. 1. *Burnetti*. Body a little broader than that of the typical form, dark olive, spotted with opaque yellow: mantle nearly black, with a few paler spots. Shell rather globular and solid, of a dull aspect, yellowish brown, closely and strongly striate in the line of growth: epidermis rather thick: the last whorl nearly covering all the others: spire exceedingly short, nearly truncate and almost intorted. L. o.725 in. B. o.65 in." (18 mm long by 16 mm. broad.) Syn. *Limnæa Burnetti* Alder; *Limnæus Burnetti* F. & H.

"Var. 2. *lacustris*. Body of a darker colour than usual. Shell resembling that of the last variety, but it is much smaller and more glossy, and has strong and regular transverse grooves, and the spire is not quite so short nor inclined to be intorted. The shell is often eroded. Syn. *Gulnaria lacustris*, Leach."

**L. (Gulnaria) peregra* Westerlund.

Synonymy after Gray ('57): *Buccinum peregrum* Müller; *Bulimus pereger* Brug.; *Helix peregra* Gm.; *H. putris* Penn.; *Lymnæa putris* Flem.; *Limnæus pereger* Drap.; *Lymnæa peregra* Lamarck; *Gulnaria peregra* Leach; *Lymnæus vulgaris* Pfeiffer; *Limnæus opacus* Ziegler; *L. fuliginosus* Z.; *L. callosus* Z.; *L. consobrinus* Z.; *L. nitidus* Z.; *L. corneus* Z.; *L. solennis* Z.; *Buccinum rivale* Studer; *Limnæa limosa* and *peregra* Mog.-Tand.; *Limnæus fontinalis* Stud.; *Limnea intermedia* Ferus; *L. thermalis* Bomb.; *L. Nouletiana*, and *Frencaleonis* Gass.; *L. glacialis* Dupuy; *Turbo trianfractus* Da Costa; *Helix inflata* Gm.; *H. teres* Gm.; *H. siccus* Dillw.; *H. auricularia* B. M. & R.; *Bulimus siccus* Brug.; *H. auricula junior* Dillw.; *Lymnæa intermedia* Lam.

"Var. 3. *lutea*. Shell remarkably solid, having a very short spire of 3-4 whorls. Syn. *Helix lutea*."

"Var. 4. *ovata*. Body of a paler colour. Shell ampullaceous and rather thinner than usual: whorls exceedingly convex, the last being larger in proportion to the rest: spire very short: suture deep: mouth very large. Syn. *Limneus ovatus* Drap."

"Var. 5. *acuminata*. Shell resembling the last variety in all respects, except in having a more produced spire and a smaller mouth."

"Var. 6. *intermedia*. Shell rather compressed towards the front margin and thinner than usual: spire more produced: mouth expanded. Syn. *Limnea intermedia* Fer."

"Var. 7. *oblonga*. Shell oblong and compressed in front."

"Var. 8. *labiosa*. Shell smaller, having the outer lip remarkably expanded and reflected. L. 0.5. B. 0.35 in." (12.5 mm. long by 8.75 mm. broad.)

"Var. 9. *picta*. Shell rather smaller than the last, and beautifully marked by alternate bands of brown and white, which are sometimes confluent."

"Var. 10. *maritima*. Shell dwarfed, rather solid: spire produced: suture deep. L. 0.4. B. 0.225 in." (10 mm. long by 5.6 mm. broad.)

"Var. 11. *Succineaformis*. Shell shaped like a *Succinea*, and very thin: whorls 4: spire small and oblique."

"Var. 12. *decollata*. Shell more or less eroded: spire truncate."

"Var. 13. *sinistrorsa*. Shell resembling a *Physa* in having the spire sinistral or reversed, rather solid: the spiral ridges distinct and prominent. Syn. *Limnaeus lineatus*."

"Var. 14. *scalariformis*. Shell oblong, with deep and regular transverse striae; whorls more or less disjoined: suture consequently very deep." Jeffreys p. 104-108.

This species is very widely distributed, being found from Siberia to Sicily. It lives in still or slowly running waters. It is nearly amphibious and may be met with some distance from the water. It is very prolific, laying about 1300 eggs in a season, the eggs being in clusters of 12-180. *L. peregra* is both zoö- and phytophagous, and is extremely variable, and no less than 30 species have been made out of its varieties.

3. *L. humilis** Say (Pl. IV, Fig. 5).—"Shell ovate-conic, thin, translucent, with slight wrinkles; volutions nearly six, convex, terminal one very minute; suture well indented; aperture about equal in length to the spire; labium with an obvious plate of calcareous deposit; a distinct and rather open umbilical aperture; color pale reddish-white or yellowish-white. Total length seventieths of an inch (8.75 mm.). Ranges from Maine to Georgia and Kansas to Lake Superior." W. G. Binney. Land and Fresh Water Shells of North America, 1865, p. 65.

*Synonymy after Binney: 1822, *L. humilis* Say; 1825, *L. modicella* Say; 1841, *L. parva* Lea; 1841, *L. plica* Lea; 1841, *L. griffithiana* Lea; 1841, *L. planulata* Lea; 1841, *L. rustica* Lea; 1841, *L. exigua* Lea; 1841, *L. curia* Lea; 1843, *L. linsleyi* de Kay.

4. *L. oahuensis** Souleyet. (Pl. IV, Fig. 1.)—Shell oblong-conic, wound right or left, thin, nearly translucent, of a tawny brown color, sometimes covered with a black and persistent coating; spire conical, generally eroded at the summit; whorls 4-5, depressed convex; mouth oval; internal lip reflected and adhering to the second last whorl; edge thin and sharp. Foot short and rather abruptly pointed posteriorly; the anterior border of the head slightly indented in the median line; tentacles are short, flattened, straight and terminated in a sharp point. Body is black.

Shell 12 mm. long by 9 mm. broad.

5. *L. rubella*† Lea. Body darker than that of *L. oahuensis*; feelers longer and more filiform, but thicker at the base, where they are triangular; teeth of radula similar to those of *L. oahuensis*. Shell sinistral, ovate-conic, thin, light and translucent with a reddish tinge; spire is short, suture shallow; whorls 5, convex. Aperture oval, 7.5 mm. Length 13 mm., breadth 6.5 mm.

The determination of the snails from the Sandwich Islands seems to be very difficult and the persons who have determined

*The original description reads as follows:

Lymnaea, testâ oblongo-conicâ, dextrâ vel sinistrorsâ, tenui, subpellucidâ, fuscâ, interdum nigratâ; spirâ conicâ; anfractibus 4-5; convexo-depressis; apice saepius eroso; aperturâ ovatâ; labio reflexo, adnato; labro tenui, acuto.

Coquille oblongue conique, dextre ou sénestre, mince, subtranslucide, d'un brun-fauve, parfois couverte d'un enduit noirâtre et persistant. Spire conique, à sommet le plus souvent rongé, et composée de quatre à cinq tours d'une forme convexe-deprimée. Ouverture ovale; lèvre interne réfléchie et adhérente à l'avant-dernier tour; labre mince et tranchant.

Cette espèce présente, comme nous venons de le dire, la particularité d'être tantôt dextre et tantôt sénestre. L'animal a le pied court et assez brusquement rétréci en pointe à sa partie postérieure; le bord antérieur de la tète est légèrement échancré sur la ligne médiane; les tentacules sont courts, aplatis, étroits et terminés en pointe aigue. Toutes ces parties sont d'un gris moirâtre.

Dimensions de la coquille.—Longueur, douze millimètres; largeur, au dernier tour, neuf millimètres.

Cette *Lymnée* habite les ruisseaux de l'île Oahu (îles Sandwich); elle y est très commune." (Souleyet, Voyage autour du Monde, sur la Corvette La Bonite, Vol. II, p. 527. Pl. 29. Figs. 38-41. 1852.)

†Original diagnosis:—

Lymnaea rubella.—Testâ ovato-conicâ, tenui lævi, nitidâ, diaphanâ, rubella, imperforata; spirâ breviusculâ; suturis parvis; anfractibus quinis, subconvexis; aperturâ subgrandi, ovatâ. *Hab.* Oahu. (Lea. On Fresh Water and Land Shells; Proc. Amer. Phil. Soc. 1841, p. 31.)

the specimens which Lutz describes have arrived at different results, as shown by the following table :

Lutz.	Böttcher.	Baldwin.	Streng.
<i>L. pereger</i> }	<i>L. oahuensis</i> Soul.	<i>L. turgitula</i> Pease.	<i>L. umbilicalis</i> Mögh.
L. No. 2. }			
L. No. 4.		<i>L. oahuensis</i> Soul.	<i>L. rubella</i> Lea.
L. No. 5.		<i>L. rubella.</i>	<i>L. sandwichensis</i> Phil.

Lutz's species Nos. 2 and 4 are the forms which serve as hosts for *F. hepatica*. To establish the proper synonymy of these animals does not come within the province of this report.

6. *L. viator** d'Orb., 1835 Body viridescent. Shell oblong, elongate, somewhat ventricose, very slightly umbilicate, thin, fragile. smooth or marked with very light lines of growth; spire more or less elongated, conical, very sharp at the tip; whorls 5, very detached, convex, separated by deep suture; mouth oval or almost round, with thin lips; columella curved, occasionally rather sinuous. Color, a uniform tawny gray. 8 mm. long by 4 mm. broad.

I am indebted to Dr. Dall of the Smithsonian Institution for the use of his private library in compiling the above data on these snails.

*D'Orbigny's description reads as follows:

L. corpore viridcente.

Testâ elongato-oblongâ, subventricosâ, subumbilicatâ, laevigatâ, tenui, livido-fuscescente; spirâ subelongatâ, conicâ, apice acuto, anfractibus quinis convexis; suturâ profundâ; aperturâ ovali; labro acuto. Long 8 mm.; lat. 4 mm.

Coquille. Oblongue, allongée, un peu ventrue, très légèrement ombiliquée, mince, fragile, lisse ou marquée de très légères lignes d'accroissement; spire plus ou moins allongée, conique, à sommet très aigu; composée de cinq tours très détachés, fortement convexes, séparés par une suture très profonde; bouche ovale ou presque-arrondie, à bords minces; columelle arquée, quelque fois un peu sinueuse. Couleur: gris-fauve uniforme.

Cette coquille varie un peu selon les localités: aux environs du Callau, au Pérou, elle est plus allongée, à tour plus détaillés; tandis qu' en Patagonie et au Chili, elle est un peu ventrue, et ses tours sont moins convexes. Au premier aperçu, nous l'avons considérée comme une simple variété du *Limnæus minutus*, de France; mais en les comparant avec le plus grand soin, nous avons reconnu que notre *L. viator* est toujours moins allongé à proportion, beaucoup moins ombiliqué, et qu'il était de plus presque entièrement lisse; tandis que le petit *Limnæus* est un peu strié; néanmoins, il est peu d'espèces qui aient plus de rapports entr'elles.

Nous avons rencontré cette espèce en Patagonie, au 41 degré de latitude sud, sur les rives de Rio negro, à commencer de sept ou huit lieues au-dessus de son embouchure, jusque bien avant sur son cours; il y est très commun. Nous l'avons retrouvé ensuite au Chili, aux environs de Santiago et de Casa blanca, toujours dans les ruisseaux d'eau limpide. Lorsque, plus tard, nous avons recherché les mollusque des environs de Lima, nous avons encore recueilli cette espèce dans tous les canaux d'irrigation qui sortant du Rimac entourent la ville de Lima et celle du Callao; mais dans ces deux localités, tous les individus sont constamment plus allongés, a tours plus séparés que celle du Chili, et de Patagonie; et, vu la différence de lieu d'habitation, nous aurions été tenté d'en former deux espèces distinctes, si nous n'avions craint de trop multiplier les espèces; et si, d'ailleurs nous n'eussions pas reconnu que les individus des environs de Lima étaient aussi moins allongés, que ceux du Callao. Dès-lors, nous avons dû croire que des circonstances locales seules avaient influé sur ce léger changement de Formes. (d' Orbigny, Voyage dans l'Amerique Meridionale, p. 340. Plate 43. Fig. 1-3).

(To be Continued.)

THE ANATOMY OF THE LARGE AMERICAN FLUKE
(*FASCIOLA MAGNA*), AND A COMPARISON
WITH OTHER SPECIES OF THE
GENUS *FASCIOLA*, S.ST.

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CONTAINING ALSO A LIST OF THE CHIEF EPIZOÖTICS OF
FASCIOLIASIS (DISTOMATOSIS) AND A BIBLIOGRAPHY
OF *FASCIOLA HEPATICA*.

BY ALBERT HASSALL, M.R.C.V.S.

(Continued from page 313.)

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THE ANATOMY OF THE LARGE AMERICAN FLUKE
(*FASCIOLA MAGNA*), AND A COMPARISON
WITH OTHER SPECIES OF THE
GENUS *FASCIOLA*, S.ST.

BY CHAS. WARDELL STILES, Ph.D.,
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CONTAINING ALSO A LIST OF THE CHIEF EPIZOÖTICS OF
FASCIOLIASIS (DISTOMATOSIS) AND A BIBLIOGRAPHY
OF *FASCIOLA HEPATICA*.

BY ALBERT HASSALL, M.R.C.V.S.

(Continued from page 417.)

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THE ANATOMY OF THE LARGE AMERICAN FLUKE
(*FASCIOLA MAGN.*) AND A COMPARISON
WITH OTHER SPECIES OF THE
GENUS *FASCIOLA*, S.ST.

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CONTAINING ALSO A LIST OF THE CHIEF EPIZOÖTICS OF FASCIO-
LIASIS (DISTOMATOSIS) AND A BIBLIOGRAPHY OF
FASCIOLA HEPATICA.

BY ALBERT HASSALL, M.R.C.V.S.

(Continued from vol. xv., 1894, page 462.)

III. *Fasciola gigantea* Cobbold, 1856.

PLATE V.

SYNONYMY:

- 1856, *F. gigantea* Cobbold.
- 1858, *Distomum giganteum* Diesing.
- 1858, *Distoma hepaticum* ex p. Gerv. et van Ben.
- 1859, *Fasciola gigantea* Cobbold.
- 1892, *Cladocœlium giganteum* ex p. Stossich.

HOST:

Giraffe (*Giraffa camelopardalis*), Liver.

GEOGRAPHICAL DISTRIBUTION: Found but once. England,
in a giraffe belonging to a travelling menagerie.

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HISTORICAL REVIEW.

COBBOLD ('54, 485) discovered several specimens of flukes of the genus *Fasciola* in the liver of a giraffe during a post-mortem examination nine days after the death of the animal. He communicated this find, according to a footnote, to the Royal Physical Society of Edinburgh on April 5, 1854. In his printed account he also mentions finding "cysticerci" in the same liver. He ('55a) presented an account of the anatomy of the worms before the same society on January 24, 1855. This time, as the title of his paper shows, he speaks of finding "cercariæ" as well. In the proceedings of the Society only a short abstract appears in type. He afterward (September, 1855) presented a paper before the British Association, and evidently published the same, with very slight changes, in two places. He states ('55b) that no less than forty specimens were washed out by means of a syringe. The diagnosis reads:

Fasciola gigantica Cobbold. Corpore compresso, elliptico-lanceolato, tres uncias longo, antrorsum attenuato; ore hausterioque antice; collo elongato, cylindrico; cauda rotundata; ventriculo dendritico, ramis clausis.

Habitat in hepate Camelopardalis giraffæ.

The parasite varies in length from $1\frac{1}{2}$ to 3 inches, averaging about 2 inches; the breadth averages 3 lines, but may be one-third of an inch; substance of the body is thinner than that of *F. hepatica*; anterior extremity prolonged forward, oral sucker half a line in diameter. Œsophagus short; 8 to 10 lateral branches to each longitudinal intestinal sac. Excretory system

consists of a single median trunk which sends branches upward and toward the sides; this system Cobbold looks upon as a circulatory system, and quotes M. Blanchard's opinion that the caudal opening results from "over-distention of the canal, which readily gives way at this its weakest point; our own (*i. e.*, Cobbold's) attempts to inject have confirmed this observation." Other organs "resemble in all respects those seen in" *F. hepatica*.



PLATE V. *F. GIGANTEA*.

FIG. 1.—Ventral view, showing digestive system and acetabulum.

FIG. 2.—Dorsal view, showing excretory system. Cobbold's figures, '64.

He then speaks in an appendix of "two kinds of cercaria found associated with the above-described trematode. One group of these cysts infested the liver, where they appeared

either at the surface in the form of small, hard, projecting points, or were thinly scattered throughout the substance of the gland. They were very numerous, and some had undergone calcareous degeneration."

The others consisted of "semi-transparent cysts in the cellular aponeurosis surrounding the stylo-glossi and lingualis muscles."

It is impossible to decide definitely, either from his description or figures, just what these "cercariae" or "cysticerci" are, although one would naturally think of *Cysticercus bovis* in connection with the form found in the tongue-muscles.

In his author's abstract ('56) the account is almost exactly the same as the one just reviewed, except that "*terunciatum longo*" appears in place of "*tres uncias longo*" in the diagnosis, and the appendix and figures are not given.

GERVAIS and van BENEDEN ('58, II, p. 201, not at my disposal), according to Cobbold, consider *F. gigantea* identical with *F. hepatica*.

DIESING ('58, p. 28, pp. 131-132, not consulted) changes the name to *Distomum giganteum*.

COBBOLD ('60, p. 4) then accepts the name *Fasciola gigantea* with the diagnosis:

"Corpus planum oblongum, lanceolatum, antrosum attenuatum, retrorsum obtusum. Collum elongatum cylindricum. Os terminale, anticum. Acetabulum ore majus, superum ad colli basin. Longit. 1-3 unc.; latit. $\frac{1}{4}$ - $\frac{1}{2}$ unc. . . . There existed in the liver (*i. e.*, of the giraffe) a number of Cysticerci; as well as three larval Distomes in cysts connected with the sublingual cellular aponeurosis."

LEUCKART ('63, I, p. 30, not consulted), according to Cobbold ('64), examined two specimens of the worm, and claims that the species "*Distomum giganteum*" is perfectly distinct from "*D. hepaticum*."

COBBOLD ('64, pp. 161-162, frontispiece, two figs.) reproduces his original figures, greatly enlarged. He makes a comparison between *F. gigantea* and *F. hepatica*, and concludes that the number of secondary branches in the intestines and excretory system of the former is greater than in the latter. The former is also larger than the latter; in form there is also a difference, in that the lower half of the body of *F. hepatica* is gradually narrowed toward the caudal point, presenting a more or less V-shaped outline; in *F. gigantea*, on the other hand, the narrowing commences very near the caudal end, the latter being bluntly curved or even truncated.

LEUCKART ('79-'94, I, 2. Abth., p. 179) accepts "*Dist. giganteum*" as a good species, and places this form with *D. Jacksoni* and *D. hepaticum* in the first subdivision (*Fasciola* Linn.) of the genus *Distomum*.

SONSINO ('90, original not obtainable here, I quote from Braun's review) seems inclined to believe that *D. magnum* and *D. giganteum* are perhaps identical.

BRAUN ('93, p. 910, Pl. XXI, 2) places *D. giganteum* in the sub-genus *Cladocœilum*, and copies one of Cobbold's figures.

Desiring to compare *F. gigantea* with *F. magna*, I have addressed letters at several different times to the Director of the Hunterian Museum, of London, asking for the loan or exchange of one or more specimens. As no response has ever reached me, I communicated with my former teacher, Geheimrath Leuckart, and asked his opinion as to the relation of the two species to each other. He replied to the effect that Cobbold's species, *F. gigantea*, is unquestionably distinct from Bassi's *D. magnum*—in fact, it resembles *D. hepaticum* more closely than it does *D. magnum*; nevertheless, that *F. gigantea* represents a true species. (See postscript at end of article.)

The species is evidently insufficiently described, and can be accepted only on Leuckart's authority.

I regret that on account of my inability to obtain specimens of *F. gigantea* I am not in a position to make any original statements in regard to its anatomy. From the above historical review, however, we may accept the following as a provisional specific diagnosis:

SPECIFIC DIAGNOSIS.

F. gigantea Cobbold, 1856. Body flat, oblong, lanceolate, 75 mm. long, 3-12 mm. broad; anterior extremity attenuate, posterior extremity obtuse; neck cylindrical; oral sucker terminal, 1.12 mm. in diameter; œsophagus extends nearly to the acetabulum; 8 to 10 lateral branches to each longitudinal intestinal sac; acetabulum larger than mouth; other organs agree with those of *F. hepatica*.

Diagnosis based upon Cobbold's description of specimens, which were taken nine days after the death of the host, and which, therefore, must have been more or less macerated.

IV. *Fasciola Jacksoni* Cobbold, 1869.

PLATE VI.

SYNONYMY:

- 1847, *Distoma hepaticum* Jackson.
 1858, *D. elephantis* Dies. sp. inq.
 1860, *D. elephantis* Cobbold.
 1869, *Fasciola Jacksoni* Cobbold.
 1892, *Cladocælium elephantis* Stossich.
 1893, *Distomum Jacksonii* Braun.

HOST:

Elephas indicus, gall-ducts.

GEOGRAPHICAL DISTRIBUTION: *North America*: Boston, Mass. (Jackson), elephant imported from East India. *South America*: Buenos Ayres, Argentine Republic (Wernicke and Herrera), in imported elephant. *Asia*: British India, Burmah (Rangoon by Thacker, Hawkes); Dominion of Hyderabad (Secunderabad by Adams).

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V. LINSTOW—

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HISTORICAL REVIEW.

JACKSON ('47, p. 322) determined as *Distoma hepaticum* some flukes found in 1835 in the gall-ducts of a young East Indian elephant which died in Boston. Later authors state that Jackson records these worms from the duodenum, as well as from the gall-ducts; but this is erroneous, as Jackson writes:

"... immense numbers were found in the ducts, and of the ascarides a few were found in the duodenum. In the same jar are several larvæ from the stomach and duodenum. There was ascites, with disease of the liver, and in the stomach near the pylorus a large, deep, chronic ulcer, of a circular form and perfectly defined. (No. 908.)"

No anatomical observations were made.



PLATE VI. F. JACKSONI.

FIG. 1.—Cobbold's figure showing digestive system, uterus, acetabulum, and cirrus (?). Evidently a dorsal view. Can the long extruded organ be a cirrus, or is it a piece of straw which got into the preparation accidentally?

FIG. 2.—*F. Jacksoni*, natural size, from an unpublished photo, given to me by Dr. Herrera.

DIESING ('58, p. 50) mentions the parasite found by Jackson

as *D. elephantis*. No description is given, so that the specific term *elephantis* cannot be accepted.

COBBOLD ('60, p. 9) also mentions the worm under the same name. Later ('69a, pp. 48-49) he received two specimens of flukes taken by Vet. Surg. J. Thacker, Madras Army, from the liver of an elephant in Rangoon. The English helminthologist recognized the form as identical with fifteen specimens which Huxley had a short time previously exhibited in his lectures before the Royal College of Surgeons. Cobbold surmised that the parasites are identical with the flukes recorded by Jackson ('47), and describes them under the name *Fasciola Jacksoni* with the following diagnosis:

F. Jacksonii, Cobbold.—“Body armed throughout with minute spines, orbicular, usually folded at either end toward the ventral aspect, thus presenting a concavo-convex form; oral sucker terminal with reproductive papilla about midway between it and the ventral acetabulum; intermittent organ one-quarter inch in length; digestive apparatus with two main zigzag-shaped canals, giving off alternating branches at the angles thus formed, the ultimate cæcal ramifications together occupying the whole extent of the body; length, one-half inch to five-eighths inch; breadth, one-third inch to one-half inch.”

Anatomically it represents a transition between *Fasciola* and *Campula*, 1857. Specimens can be seen in the Museum of the Royal College of Surgeons.

The same year ('69b, p. 80, Fig. 3) he reprints this diagnosis, changing it only in one place, so that it reads: “. . . length, when unrolled, from one-half inch to five-eighths inch.” In his *Manual* ('73, p. 13) Cobbold refers to *F. Jacksonii* as the cause of death of some of the elephants in Burmah, in order to illustrate that larger animals readily succumb to inflammatory disorders produced by flukes.

FITZ ('76) then studied the material recorded by Jackson, identified the specimens as *F. Jacksoni*, and published an anatomical description of the same (unfortunately without illustrations). The following presents a summary of his results:

The general form, dimensions, and the arrangement of the intestine agree with Cobbold's diagnosis; genital papilla absent, in its place a depression, into the lower part of which opens the vagina, while the opening for the penis is in the posterior wall nearer the ventral surface; spines are absent, but the abdominal surface possesses ridges directed caudad, and traces of such ridges are found on the dorsal aspect of the neck; cellular structure and muscular bands agree with those described by Leuckart (1st ed.) for *F. hepatica*; oral sucker is followed by a voluminous bottle-shaped pharynx, the latter by a short crenated oesophagus; the secondary branches of the intestinal tubes arise almost invariably from the *posterior* aspect of the tubes from which they branch; post-buccal ring between oral sucker and pharynx; shell-gland round, of considerable size, rather dorsal in position and behind (=caudad) of the seminal vesicle; “above” the ootyp “communicates by a short, narrow tube with the conjoined yolk and ovarian ducts;”

ovaries ventral, a short distance behind the ventral sucker, and are two "large convoluted tubes with blind projections. These tubes unite near the median line into a single tube or duct, which passes upward toward the front of the shell-gland, becomes very narrow, and at one point sharply constricted. Into this narrow duct beyond the constriction enters the vagina" (Laurer's canal) "and the tube then unites with the yolk-duct, forming a T-shaped figure, the lower arm of which enters the gland." The yolk-glands agree with those of *F. hepatica*, the yolk-duct "uniting with the ovarian duct." The convolutions of the uterus lie rather behind (—caudad) and around the ventral sucker; testicles agree in general with those of *F. hepatica*. Author believes copulation takes place through Laurer's canal.

THE ANATOMY OF THE LARGE AMERICAN FLUKE
(*FASCIOLA MAGNA*) AND A COMPARISON
WITH OTHER SPECIES OF THE
GENUS *FASCIOLA*, S.ST.

BY CHAS. WARDELL STILES, PH.D.,
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CONTAINING ALSO A LIST OF THE CHIEF EPIZOÖTICS OF FASCIO-
LIASIS (DISTOMATOSIS) AND A BIBLIOGRAPHY OF
FASCIOLA HEPATICA.

BY ALBERT HASSALL, M.R.C.V.S.,

(Continued from vol. xvi., 1895, page 147.)

COBBOLD ('79, pp. 393-400), in discussing the parasites of elephants, refers a number of times to *F. Jacksoni*:

The fifteen specimens possessed by Huxley, mentioned above, were removed from Burmese elephants in the summer of 1868 and sent to him from Rangoon, with a statement that they caused an extensive and fatal disease in Burmah; an historical review of this species up to 1879 is given; extracts from letters by General Hawkes (May 12, and July 30, 1875) are given regarding this parasite; as these extracts are very interesting, and to a certain degree important, it may be well to quote them:

"My attention has been recently directed to a very unusual mortality of elephants at this station. Out of twenty-eight elephants under my charge no less than twelve have died within the last sixteen months, whereas the average annual mortality has been hitherto only two per annum out of thirty-eight in our establishment. In every case of death there appeared to exist serious organic disease quite sufficient to account for such death, but as the mortality increased I had a post-mortem examination made in each case; and although here also organic disease sufficient to account for death was present in each case, yet in every one of these elephants we found liver-flukes in greater or less abundance. The only other published notice that I have been able to find of it is contained in a letter to a newspaper dated 'Rangoon, July 16, 1867, and is signed R. B.' In this letter the unusual mortality of seven elephants in about fifteen days is attributed to the presence of this liver-fluke, the two other parasites (*Amphistoma Hawkesii* and *Ascaris lonchoptera*) being also present in the intestines. Now in every case at which I was present flukes were found in greater or less numbers in the gall-ducts of the liver, and the *Amphistoma* was also as constantly present in the intestines, the soorti (*Asc. lonchoptera*), contrary to the general experience of the elephant attendants, being less frequently met with, though from its color and slender shape it is not so easily detected among the huge masses of fæces as the larger *Amphistoma*."

Both *Amphistoma* and *Fasciola Jacksoni* are reported in a case in the Secunderabad epizooty. In a report of a later case by the veterinary surgeon (W. S. Adams) is found this statement:

I carried out the post-mortem examination with special reference to inquiry as to the probability of mortality among elephants at this station being of parasitic origin. This was suggested to me by the former case. The post-mortem appearances differed in every respect. There were flukes in the liver, but in no great quantity, and the structure of the liver was sound. Although not assisted by this case in attributing the mortality to parasitic origin, I am strengthened in my opinion that the death of the previous elephant was due to disease caused by the presence of the liver-fluke.

Von LINSTOW ('78, p. 45) records three species of liver-flukes (*D. hepaticum* Abildgaard, *D. elephantis* Jackson, and *D. Jacksoni* Cobbold) in *Elephas indicus*. Evidently the papers in which Cobbold stated that these recorded cases have reference to but one species have escaped his notice.

COBBOLD ('82, No. 11, pp. 242-246, Fig. 11, Pl. 24, Fig. 12) gives a new diagnosis of the species now under consideration:

"Body flat, orbicular, often folded toward the ventral surface, smooth to the naked eye, but armed throughout with numerous excessively minute dermal spines, which are larger above than below. Oral sucker terminal, small. Ventral sucker large and well forward. Reproductive papilla in the middle line, and placed considerably above the upper lip of the acetabulum; intromittent organ of great length. Digestive apparatus branched, its ramifications ending in cæcal terminations, which occupy nearly the whole extent of the body internally; œsophageal bulb distinct. Length, $\frac{1}{2}$ to $\frac{5}{8}$ of an inch; breadth, $\frac{1}{3}$ to $\frac{1}{2}$ of an inch. *Hab.* Biliary ducts and duodenum of *Elephas indicus*."

Cobbold again takes occasion, as he did many times before, to insist upon the priority of the generic term *Fasciola* for flukes with dendriform intestines and to the injustice of using the term *Distoma* for these flukes; he claims that spines are present in *F. Jacksoni*; they measure 1700 to 1750 of an inch long by $\frac{1}{2000}$ of an inch thick (basal diameter); they are independent of the ridges described by Fitz, and are regularly arranged at equidistant points; in *F. hepatica* the spines are twice as long and three times as broad; the general dendriform arrangement is more or less similar in different specimens, but individual variation is naturally found; in specimens preserved in alcohol the greenish tint, due to bile, of the fresh specimen is not entirely destroyed; eggs are oval, 1230 inch long by 1330 inch broad, provided with a lid at one end; sexual openings in a depression, occasionally well marked, however, a papillary eminence can be distinguished in the centre of the depression.

BRAUN ('93, p. 910) places this species in the genus *Distomum*, sub-genus *Cladocœlium*, and remarks (p. 376) that Fitz has mistaken the vitellogene glands for the ovary. I cannot quite agree with my distinguished German colleague in this criticism.

Fitz evidently recognized the vitellogene glands, and he must also have seen the ovary. Whether he has also mistaken some other portion of the genital organs for a portion of the ovary is difficult to state, as his description is open to criticism, and as he fails to give figures.

SPECIFIC DIAGNOSIS.

F. Jacksoni Cobbold, 1869. Body, 12 to 16 mm. long by 8 to 12 mm. broad, flat, orbicular, often folded ventrally, smooth to naked eye, but armed throughout with minute spines, dorsal spines larger than ventral spines. Oral sucker terminal, small; ventral sucker large, well forward; genital papilla anterior to acetabulum; penis very long. Pharynx large, œsophagus (after C.'s figure) absent; intestinal cæca dendritic, median branches long. Other organs same as *F. hepatica*.

V. The generic name *Fasciola*.

It is very generally admitted that the generic term *Fasciola* has priority over the term *Distomum*, and yet the latter term in some countries, at least, has entirely supplanted the former. In German literature of the present day *Fasciola* is hardly ever used. In French literature *Fasciola* is only occasionally met with. In English and American writings we find the term *Fasciola* more frequently than in the writings of other countries, yet not so frequently as the term *Distomum*. As I now take up the term *Fasciola*, it may be well to briefly review the generic history of the four flukes considered in this paper.

Fasciola was first proposed by Linné in 1746, and was also used in the tenth edition of the *Systema Naturæ* (1758). Linné included in the genus not only the liver-fluke, but also *Planaria* and *Schistocephalus*. The name *Distoma* Retzius was not proposed until 1786, and accordingly should not under any circumstances be allowed to supersede *Fasciola*. Goeze (1782) placed *F. hepatica* (the only species of the genus *Fasciola* s.st. known at the time) in his *Naturgeschichte* under the name *Planaria latiuscula*. Zeder reverted to *Distoma*. Dujardin¹ (1845) accepted the generic term *Distoma*, and proposed a division of the flukes into nine sub-genera. His first sub-genus (*Cladocœlium*) contained *D. hepaticum* as the type and only species, and was characterized by the ramified intestinal branches ("Intestin à

¹ Histoire Naturelle des Helminthes. Paris, 1845. Vide p. 388.

deux branches rameuses"), in contra-distinction to all other distomes known to him, the rest possessing simple intestinal cæca.

Fasciola hepatica continued, however, to be known under the generic terms *Fasciola*, *Distoma*, or *Distomum*, according to the individual tastes of the various authors. Blanchard and Cobbold upon several occasions insisted upon the priority of the term *Fasciola* for flukes of the type of *F. hepatica* (i. e., Dujardin's sub-genus *Cladocælium*), and the latter, in 1868, published a *Synopsis of the Distomidæ*, in which the genus *Fasciola* is adopted for *F. hepatica* and *F. gigantea*, and in 1869 the species *F. Jacksoni* was added to it. As generic description of *Fasciola* Cobbold gives "the presence of a branched intestinal canal divided into numerous cæcal appendages." For the other distomes Cobbold created several genera, but few of them have been generally adopted, and they need not enter into the discussion here, for we are interested at the present moment only in flukes of the type of *F. hepatica*. Leuckart, in his *Parasiten des Menschen*, accepted *Fasciola* only as a sub-genus of the genus *Distomum*, giving as sub-generic diagnosis the following:

"Body¹ of considerable size, broad and leaf-shape, provided with conically projecting anterior portion. The uterine loops are arranged almost like a rosette, posterior to the acetabulum. Intestine racemose and highly developed. The testicles are also racemose and highly developed, and occupy the entire middle field of the posterior half of the body."

Leuckart places in this sub-genus *D. hepaticum*, *D. Jacksoni* and *D. giganteum*.

Monticelli² then reverted to the sub-genus *Cladocælium*, and quite recently Max Braun³ adopted (evidently only provisionally) a modification of Dujardin's system, in which he admits eight of Dujardin's sub-genera, including under *Cladocælium* ("Darm mit zwei verästelnden Schenkeln") *D. hepaticum* L., *D. giganteum* Cobbold, *D. Jacksonii* Cobbold, *D. magnum* Bassi, *D. delphini* Poir., *D. palliatum* Looss, *D. Rochebruni* Poir., and *D. oblongum* Cobd. He accepts the generic name "*Distomum* Retz, 1776," remarking (p. 894) that the name "*Fasciola* L. 1746, enthält

¹ Körper von ansehnlicher Grösse, breit und blattförmig, mit einem zapfenartig vorspringenden Vordertheile. Die Uterus-windungen hinter dem Bauchsaugnapfe fast rosettenartig zusammengelegt. Darm verästelt und von mächtiger Entwicklung. Ebenso die Hoden, die mit ihren Zweigen das Mittelfeld der hintern Leibeshälfte vollständig ausfüllen.

² Saggio di una morfologia dei Trematodi. Napoli, 1888. Unfortunately this paper is not at my disposal, but I quote from Blanchard and from Braun.

³ Vermes: Bronn's Klassen und Ordnungen, etc., p. 909.

Distomum, *Planaria*, und *Schistocephalus* und ist nach Abtrennung der beiden letzten für die Distomen fast ganz ausser Gebrauch gekommen."

Stossich,¹ in a revision of distomes, raised the sub-genus *Cladocœlium* to generic rank, and included in it the species *C. hepaticum*, *C. elephantis*, *C. giganteum*, *C. delphini*, *C. palliatum*, and *C. Rochebruni*.

Summing up these statements the generic synonymy of flukes of the type *F. hepatica* would be as follows :

1746 et 1758, *Fasciola* Linné.

1782, *Planaria* Goeze.

1786, *Distoma* Retz.

1800, *Distoma* Zeder.

1809, *Distoma* Rud.

1845, *Distoma* (*Cladocœlium*) Duj.

1845, *Fasciolaria* (Anonymous).

1850, *Distomum* Dies.

1858, *Fasciola* (Linné, pars.) Cobbold.

1884, *Distomata* Taylor.

1888, *Distoma* (*Cladocœlium*) Monticelli.

1889, *Distomum* (*Fasciola*) R. Lkt.

1892, *Distomum* (*Cladocœlium*) Braun.

1892, *Cladocœlium* Stossich.

1894, *Fasciola* Wilder.

It is perfectly evident from the above that Retzius' name *Distoma* or Stossich's generic (Dujardin's sub-generic) name *Cladocœlium* cannot be used instead of *Fasciola* without a total disregard for the law of priority. Accordingly, if the heterogeneous mass of distomes is included under one generic term, *Fasciola* must stand as the name of the genus. If the genus is divided (and this certainly must be done sooner or later), the genus with *F. hepatica* as type-species must receive the name *Fasciola*. Personally, I believe that flukes of the type of *F. hepatica* should be separated from the remaining distomes. The forms which authors have brought into close relationship with *F. hepatica* are: *F. gigantea*, *F. Jacksoni*, *F. magna*, *D. delphini* Poir., *D. palliatum* Looss, *D. Rochebruni* Poir., and *D. oblongum* Cobbold.

The forms *F. hepatica*, *F. gigantea*, *F. magna*, and *F. Jacksoni* agree in the following particulars :

¹ I Distomi dei Mammiferi; Estratto dal Programma della civica Scuola Reale superiore. Trieste, 1892.

1. The worms are hermaphrodites; body broad and flat.
2. The intestinal cæca are profusely branched.
3. The testicles are profusely branched and are situated on nearly the same height, for the greater part posterior to the transverse vitello-duct.
4. The ovary is branched and situated anterior to the transverse vitello-duct.
5. The vitellogene glands are enormously developed and occupy the margins of the entire worm, posterior to the acetabulum.
6. The uterus forms a rosette posterior to the acetabulum.
7. The genital pore is about half-way between the sucker and the acetabulum.
8. A cirrus is present.

Hab. Liver of various herbivorous animals.

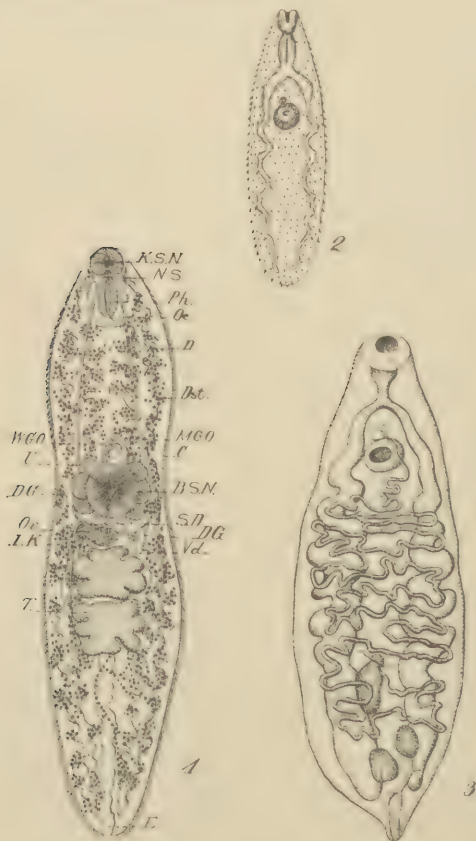


PLATE VII.

FIG. 1.—*Distomum palliatum* Looss. *K.S.N.*, oral sucker; *B.S.N.*, acetabulum; *N.S.*, nervous system; *Ph.*, pharynx; *Oe.*, oesophagus; *D.*, intestinal cæca; *E.*, excretory system; *C.*, cuticle with spines; *M.G.O.*, male genital opening; *W.G.O.*, female genital opening; *U.*, uterus; *S.D.*, shell-gland; *D.G.*, vitello-ducts; *Dst.*, vitellogene glands; *L.K.*, Laurer's canal; *Vd.*, vas deferens; *T.*, testicles; *Ov.*, ovary. After Looss, reduced.

FIG. 2.—*D. oblongum* Cob. After Cobbold, 1864, reduced.

FIG. 3.—*D. oblongum* Cob. After Cobbold, 1879, reduced.

D. palliatum Looss, 1884 (Plate VII., Fig. 1), presents the following characters:

1. Hermaphrodite; body narrow.
2. The intestinal cæca are but very slightly branched.
3. Testicles are lobate, one lying posterior to the other, both posterior to the transverse vitello-duct.
4. Ovary is slightly lobate and lies posterior to the transverse vitello-duct.
5. Vitellogene glands are not so profusely developed as in *F. hepatica*, etc., but extend some distance anterior to the acetabulum.
6. Uterus forms a rosette dorsally of the acetabulum.
7. Genital pore is only slightly anterior to the acetabulum.
8. Cirrus present.

Hab. Liver of *Delphinus delphis*.

D. delphini Poirier, 1886 (Plate VIII., Figs. 1-3) shows the following characters:

1. Hermaphrodite; narrow body.
2. Intestinal cæca are branched about as much as *D. palliatum*.
3. Testicles are ovoid, one posterior to the other, both posterior to the transverse vitello-duct.
4. Ovary spherical, anterior to transverse vitello-duct.
5. Vitellogene glands profusely developed, and extend anterior to acetabulum.
6. Uterus does not form a rosette (Cf. Poirier's figure), and is situated for the greater part posterior to acetabulum.
7. Genital pore is only slightly anterior to the acetabulum.
8. Cirrus evidently present.

Hab. Liver of *Delphinus delphis*.

D. Rochebruni Poir., 1886 (Plate VIII., Figs. 4, 5) presents the following characters:

1. Hermaphrodite; narrow.
2. Intestinal cæca same as in *D. delphini*.
3. Testicles ovoid, one posterior to the other, both in anterior half of body posterior to transverse vitello-duct.
4. Ovary spherical, anterior to transverse vitello-duct.
5. Vitellogene glands as in *D. delphini*.
6. Uterus as in *D. delphini*.
7. Genital pore as in *D. delphini*.
8. Cirrus present.

Hab. Liver of *Delphinus delphis*.

D. oblongum (Cobbold) (*Campula oblonga* Cobbold, *Distomum campanula* Cobbold, 1876) (Plate VII., Figs. 2, 3), like most of Cobbold's species, is very poorly described. From his figures, however, we can take the following characters:

1. Hermaphrodite; narrow.
2. Intestinal cæca zigzag in form, but not dendritic.
3. Testicles round to oval, one posterior to the other, both in posterior portion of the body, posterior to transverse vitello-duct.
4. Ovary. ? (From Cobbold's figures it is impossible to tell with certainty which of two organs drawn is the ovary, one of them is nearly spherical and lies anterior to the transverse vitello-duct, the other (probably this one is the receptaculum seminis) is somewhat oval and lies posterior to the vitello-duct.)
5. Vitellogene glands?

6. Uterus long, extends anterior and posterior to ovary: does not form a rosette.
7. Genital pore immediately anterior to acetabulum.
8. Cirrus?

For this fluke, which Cobbold considered intermediate between *Fasciola* and *Distoma*, he proposed the generic term *Campula*, but he afterward rejected the genus. It seems to be a *Dicrocoelium*, second section.

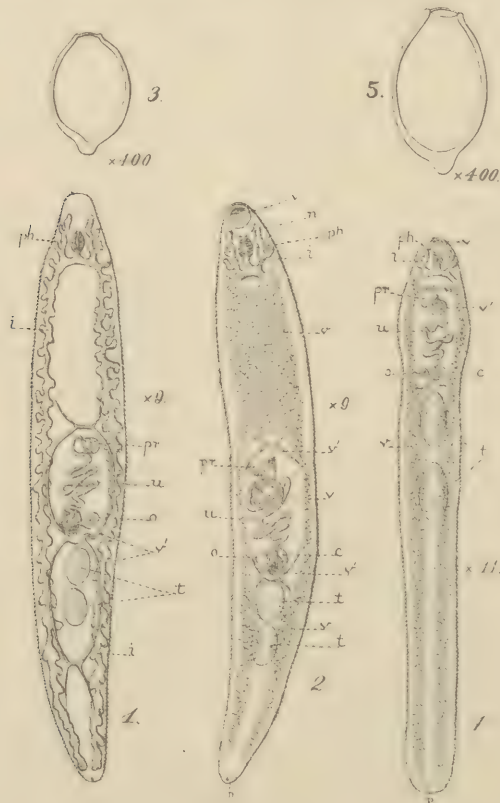


PLATE VIII.

FIG. 1.—*D. delphini* Poir. After Poirier, 1886. Dorsal view. *Ph*, pharynx; *i*, intestinal cæca; *pr*, cirrus-pouch; *u*, uterus; *o*, ovary; *v'*, vitello-ducts; *t*, testicles.

FIG. 2.—The same, ventral view. After Poir., 1886. *V*, oral sucker; *V'* acetabulum; *n*, nervous system; *v*, vitellogene glands; other letters the same as in Fig. 1.

FIG. 3.—Egg of *D. delphini*. After Poir., 1886.

FIG. 4.—*D. Rochebruni* Poir. After Poirier, 1886. Letters the same as in Figs. 1 and 2.

FIG. 5.—Egg of *D. Rochebruni*. After Poir., 1886.

All figures reduced to two-thirds of original drawings.

From the above analysis of characters, I think it perfectly

evident that *D. oblongum* is too insufficiently known to enter into consideration. Looking at the other forms we find that they represent two distinct groups, one containing *F. hepatica*, *F. gigantea*, *F. magna*, and *F. Jacksoni*, the other containing *D. palliatum*, *D. delphini*, and *D. Rochebruni*.

The only important character common to these two groups (aside from the hermaphroditism and presence of a cirrus) is the branching of the intestinal cæca, these being *profusely* branched in the first group, and but *slightly* branched in the second group. They differ from each other in the following characters:

	FIRST GROUP.	SECOND GROUP.
Ovary	End at or very near the acetabulum.	Extend far anterior to the acetabulum.
Testicles	Profusely branched, may be side by side, or nearly so.	Ovoid to lobate; one posterior to the other.
Vitellogene glands	Branched.	Spherical to lobate.

These correlated differences seem to me ample grounds for not uniting flukes of the type of *F. hepatica* with flukes of the second group. Certainly the branching of the intestines could easily occur as a parallelism in different genera, and the very fact that the branching is so much slighter in the second group than in the first, coupled with the other divergent characters, seems to indicate that the branching in *D. palliatum* is probably of more recent origin in this group than in *F. hepatica*; if that is true, then the second group is of entirely different origin from the first, and hence not generically related. If these seven flukes, however, are placed in the genus *Fasciola*, we must not forget that the genus is practically established upon a single character, and is very artificial. The first four flukes mentioned, on the other hand, agree in more than one important character, and represent a very compact and natural group; this fact, I believe, justified Cobbold in defining the genus *Fasciola* as he did.

If, on the other hand, we are to unite other flukes in this genus, then *D. crassum* must receive our attention, for that certainly resembles *F. hepatica* as much as do *D. palliatum*, *D. delphini*, and *D. Rochebruni*.

While agreeing thoroughly with Braun that the time has not yet come to establish definite genera for all the different forms included under the collective generic term *Distomum*, I consider

that when we find a distinct group which contains several evidently very closely allied species differing very materially from the other forms—as in the case of the four species mentioned in this paper—it is best to recognize them as a distinct genus.

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(*FASCIOLA MAGNA*) AND A COMPARISON
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CONTAINING ALSO A LIST OF THE CHIEF EPIZOÖTICS OF FASCIO-
LIASIS (DISTOMATOSIS) AND A BIBLIOGRAPHY OF
FASCIOLA HEPATICA.

BY ALBERT HASSALL, M.R.C.V.S.,

(Continued from vol. xvi., 1895, page 222.)

VI. Conclusions.

[These conclusions were printed as a summary of this article: Notes sur les Parasites, 25: La Grande Douve Américaine (*Fasciola magna*); Bul. Soc. Zoöl. d. France, xix., No. 6, séance du 22 Mai (pub. Juin), pp. 91-94.]

The conclusions reached in this paper may be briefly summarized as follows:

1. The generic term *Fasciola* must be retained for flukes of the type of *F. hepatica*.
2. As flukes of this type can be considered *F. magna*, *F. gigantea*, and *F. Jacksoni*.
3. The union of *D. palliatum*, *D. delphini*, *D. Rochebruni*, and *D. oblongum* with the four above-named species of *Fasciola* in a sub-genus of the genus *Distomum* results in the formation of an unnatural and artificial group.
4. Of these four species *D. oblongum* is too poorly described to be taken into consideration; it is probably a *Dicrocælium* second section.
5. The other three species agree but slightly with *Fasciola*, possessing a somewhat branched intestine, but differing in other very important characters.
6. I therefore propose to follow Cobbold in limiting the genus *Fasciola*¹ (type species *F. hepatica*) and suggest the following as a revised generic diagnosis:

¹ Cf. Règles de la Nomenclature des êtres organisés, Art. 34

Fasciola (Linné, pars), type species *F. hepatica*. Hermaphroditic flukes, of the family *Distomidae*; body large, broad, and more or less leaf-shape (flat), with a more or less distinctly developed anterior conical portion bounded from the broad posterior portion by the ventral acetabulum; œsophagus present; intestinal cæca profusely branched; ovary branched, situated for the greater part anterior to transverse vitello-duct; vitellogene glands highly developed and occupying the margins of the posterior portion, ending anteriorly at about the height of the acetabulum; uterus in form of a rosette, anterior to transverse vitello-duct, dorsal and posterior (caudad) to the acetabulum; genital pore about midway between acetabulum and oral sucker; testicles branched, situated for the greater part posterior to transverse vitello-duct; penis present. Oviparous.

Hab. Liver and lungs of herbivorous mammals.

7. The following table will aid in determining the four known species of this genus; the characters relating to *F. Jacksoni* and *F. gigantea* are not satisfactory, but are the only ones which can be taken at present:

1.	Median branches of intestinal cæca ¹ long; œsophagus absent; body orbicular, 12 to 16 mm. long by 8 to 12 mm. broad; hab., biliary ducts of Indian elephant <i>F. Jacksoni</i>	p. 144, 1895
	Median branches of intestinal cæca short; body rarely orbicular 2	
2.	œsophagus ¹ extends nearly to acetabulum; body lanceolate, 75 mm. long, 3 to 12 mm. broad; anterior conical portion distinct; posterior extremity obtuse; hab., biliary ducts of giraffe <i>F. gigantea</i>	p. 139, 1895
	œsophagus extends half-way to acetabulum or less 3	
3.	Body, flesh-colored, very large and thick, rarely orbicular; 20 to 100 mm. long by 11 to 26 mm. broad; anterior conical portion not very distinct from posterior portion; posterior extremity bluntly rounded; vitellogene glands situated ventrally of the intestine; œsophagus generally one-and-a-half to three times as long as the pharynx; hab., liver and lungs of cattle, deer, etc. <i>F. magna</i>	p. 172, 1894
	Body, 25 to 35 mm. long by 2 to 4 mm. broad; anterior conical portion much more distinct than in the case of <i>F. magna</i> ; posterior extremity bluntly pointed; vitellogene gland both dorsal and ventral of intestine; œsophagus rarely one-and-a-half times as long as the pharynx <i>F. hepatica</i>	

8. If the genus *Fasciola* s.st. is not recognized as distinct from the other distomes, then the generic term *Fasciola* must be used in place of *Distomum*.

¹ Based upon Cobbold's figures.

9. As Cobbold failed to state definitely what species he took as the type¹ of the genus *Distomum*, I propose, in order to place the matter beyond doubt, to accept the first species in Cobbold's list, *i. e.*, *Distomum lanceolatum*, as type-species of the genus.

10. As *F. hepatica* was the only species of Dujardin's sub-genus *Cladocœlium*, and hence the type of that sub-genus, the name *Cladocœlium* must fall into synonymy with the separation of *Fasciola* from *Distomum*, and can accordingly not be retained in the genus *Distomum*.

11. *D. palliatum*, *D. delphini*, and *D. Rochebruni*, upon being rejected from the genus *Fasciola*, can be left in the collective genus *Distomum* for the present, but as they differ considerably from the type (*D. lanceolatum*), it is doubtful whether they can remain long in this genus.

12. *F. magna* agrees very closely with *F. hepatica* in the anatomy of the adult, the egg and the miracidium, and it is very probable that the development will be found to be very similar.

13. *F. magna* has a wide distribution in the United States of North America, being very common in certain Southern States (Texas); it has been found also in Northern and Western States (New York, Iowa, Arkansas, Indian Territory, and California); but its frequency in some of these latter States is not determined.

14. It is found in both domesticated and wild animals, sometimes alone, sometimes associated with *F. hepatica*.

15. It has, as Bassi has shown, been introduced into Italy by *Cervus canadensis*, imported from North America.

16. Its close resemblance to *F. hepatica* suggests that it is but a comparatively short time since these two species have become distinct from each other; it is, however, impossible to state whether it existed in this country in wild animals before the discovery of America, and has since become a parasite of domesticated cattle, or whether the parasites were originally introduced with domesticated animals (as *F. hepatica*), and have since then become differentiated into a new species, *F. magna*, which has spread to wild animals.

¹ Cf. Règles de la Nomenclature des êtres organisés, Art. 35 (1889, 1893).

VII. Compendium of Fasciolas arranged according to their hosts.

A * before a specific name signifies that I have examined specimens of the parasite in question from the host given; the other cases are compiled. Where the specific name of the parasite is in italics, this species is not given for the host in question in von Linstow's *Compendium* or *Nachtrag*. In cases where the parasite is queried (?) the species has been reported for the host in question, but there is probably a mistake in the specific determination.

Antelope picta Pallas, 1777, *vide* BOSELAPHUS TRAGOCAMELUS (Pallas), 1767

BOS BUBALIS L. Indian buffalo.

F. hepatica.

BOS TAURUS. Domesticated cattle.

*F. hepatica.

**F. magna*.

BOSELAPHUS TRAGOCAMELUS. Nilgai or blue bull.

F. hepatica.

F. magna.

CAMELUS BACTRIANUS L. Bactrian camel.

F. hepatica.

CAPRA HIRCUS L. Goat.

F. hepatica.

CAVIA COBAYA Schreb. Guinea-pig.

F. hepatica.

CARIACUS VIRGINIANUS. Common deer, Virginia deer.

F. hepatica (?).

F. magna.

CASTOR FIBER. European beaver.

F. hepatica.

Cervus aristoteles Cuv., 1825, *vide* C. UNICOLOR Bechstein, 1799.

CERVUS CANADENSIS. Elk or wapiti.

F. magna.

CERVUS DAMA. Fallow deer.

F. hepatica (?).

F. magna.

CERVUS ELAPHUS. Stag.

F. magna.

CERVUS UNICOLOR. (C. aristoteles). Sanbur, rusa deer.

F. magna.

ELEPHAS INDICUS. Indian elephant.

F. hepatica (?).

F. Jacksoni.

EQUUS ASINUS. Ass.

**F. hepatica.*

EQUUS CABALLUS. Horse.

**F. hepatica.*

FELIS DOMESTICA. Cat.

F. hepatica. (*Vide* Stossich '92, p. 8.)

GAZELLA DORCAS. Gazelle.

F. hepatica.

GIRAFFA CAMELOPARDALIS. Giraffe.

F. gigantea.

HOMO SAPIENS. Man.

F. hepatica.

LEPUS CUNICULUS. Wild rabbit.

F. hepatica.

LEPUS CUNICULUS DOM. Domestic rabbit.

F. hepatica.

LEPUS TIMIDUS. Hare.

F. hepatica.

MACRUPUS GIGANTEUS. Great gray kangaroo.

F. hepatica.

ORCA GLADIATOR (*vide* p. 302). Grampus "Killer."

**F. hepatica.*

OVIS ARIES L. Sheep.

**F. hepatica.*

OVIS ARGALI. BODD. Argali.

F. hepatica.

Portax picta Horsfield, *vide* BOSELAPHUS TRAGOCAMELUS (Pallas), 1767.

SCIURUS VULGARIS. European squirrel.

F. hepatica.

SUS SCROFA DOM. Swine.

F. hepatica.

POSTSCRIPT. Since the manuscript of this article was finished over a year ago, several points have come up which it may be well to cover briefly in a postscript.

Type specimens of F. gigantea and F. Jacksoni. Prof. C. Stewart, of the Royal College of Surgeons of London, writes me that there are no duplicates of these specimens in their museum.

F. hepatica in Honolulu. Dr. A. R. Rowat has forwarded specimens of *F. hepatica* from a horse, and in his letter (September 14, 1894) mentions a case of the occurrence of "a fluke" in a woman; only one specimen was passed, details of which were not given.

The generic term FASCIOLA. Prof. Max Braun, in reviewing *Notes sur les Parasites*, 25, speaks against my position in using the generic term *Fasciola* in the most emphatic language. As the latter part of this paper appears after Braun's review, a reply may possibly be expected from me by some of my friends. In the review, however, the German helminthologist promises to return to the subject upon the appearance of the present paper, so that any addition to my article upon this score at present would be premature. I will simply state that notwithstanding Braun's views, which, by the way, are simply stated and not supported by arguments, I see no reason for altering my opinions upon this subject as expressed a year ago. That I do not stand alone in the views expressed regarding *Fasciola* is shown by the appearance within a short time of two scientific publications by the French helminthologist, Raphael Blanchard, in which *Fasciola* is adopted.

Stossich (1892, I Distomi degli Uccelli—the same paper in which his subgenus *Polyorchis*, 1888, is given generic rank, cf. and strike out foot-note p. 737 of note 30) adds *Distomum holostomum* Rud., 1819, and *D. sulcatum* Linston, 1883, two avian parasites, to the genus *Cladocœlium* (-*Fasciola*). There are no specimens of these parasites in the B. A. I. collection, but judging from the descriptions given I cannot see that they have any generic relationship with *F. hepatica*.

